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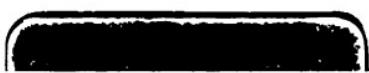
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PRACTICE
OF
MEDICAL ELECTRICITY
—
POWELL.







THE PRACTICE
OF
MEDICAL ELECTRICITY,
SHOWING
THE MOST APPROVED APPARATUS, THEIR METHODS OF
USE, AND RULES FOR THE TREATMENT OF
NERVOUS DISEASES,
MORE ESPECIALLY
PARALYSIS AND NEURALGIA.

BY

G. D. POWELL, M.D., L.R.C.S.I.
&c. &c. &c.



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PREFACE TO SECOND EDITION.

THE favourable reception given to the first issue of this small treatise, proves the growing wish among medical men to employ the agency of electricity in the treatment of disease.

All those who are interested in this branch of medicine, must view with pleasure the abandonment of the narrow doctrine "that the therapeutic properties of electricity is only one of local stimulation," and accept the fact which experience confirms—that in it we have an unsurpassed means of improving the general nutrition, in the great number of chronic morbid conditions, where such results are indicated. As proved elsewhere, I have shewn that the

therapeutic properties of electricity are stimulant, tonic, sedative, antispasmodic, and resolvent, according to the manner in which it is applied, and the form of the agent used.

It is to be regretted that the literature of chronic nervous disease is nearly all of foreign authorship, and has been based on hospital rather than on private practice: for types of disease are influenced as much by social position and occupation as by race or climate; and it is well known to those in practice, that in the higher walks of life there are far more suffering from various affections known as "nervous dyspepsia," "debility," &c. (indefinite though they may be), than all forms of paralysis combined, and it is safe to assert that general electrization promises almost sure relief from this condition.

It would be well if medical men would report more fully their experience in this matter, and give to the profession favourable as well as unfavourable cases, always remembering that those *who know* most of electricity in its relation to

medicine, will not regard it as an infallible specific.

The need for additional information may be gleaned from an article on this subject in the *Practitioner*, of September, 1871, a portion of which we quote. The italics are mine. "There is nothing more striking in recent therapeutics than the change which has come over the attitude of the profession—at any rate of its leaders—in regard to the employment of electricity in medicine. *Only ten years ago to announce one's self a believer in electricity as a remedy of positive value, was a hazardous thing; one was apt to be met directly with an incredulous smile and shrug of the shoulders, and indirectly with the damaging rumour that one was taking to quackery.* Even now there are men, some of them even highly placed in the profession, especially in England,* who pertinaciously refuse to acknowledge any real worth in the treatment. The especial incredulity of English medical

* The editor might, with equal justice, have added Ireland also.

men may be readily accounted for by two facts. In the first place, medico-electric quacks have been especially rampant, and exceptionally dishonest and incapable in this country; and secondly, *the ignorance of the English medical profession concerning the elements of electrical science*, was something profound and amazing. *It is a fact that, till quite lately, not one English doctor in a thousand was acquainted with any other practical means of applying medical electricity than the common magneto-electric machine; that the latter was commonly spoken of as a ‘galvanic battery;’ that if any one talked of continuous and interrupted currents, he was regarded with a puzzled stare,” &c.*

This is quoted with the view of showing what the leading therapeutic journal in England thinks of the subject, and to point out the need for more searching, and above all, *practical information*. It is with the latter object in view, this small volume is compiled, and the reader who may wish for further information is referred



to other more voluminous works, a few* of which are mentioned in the adjoining note, and from which much has been quoted in this volume.

* "Electricity in its relations to Practical Medicine." By Dr. Meyers, Berlin. A translation is published by Appleton, New York.

"Medical uses of Electricity." By Dr. Garratt, Boston.

"A Practical Treatise on the Medical and Surgical Uses of Electricity." By Drs. Beard and Rockwell, New York, 1871.

"De l'Electrisation Localisée et son Application à la Physiologie, la Pathologie, et la Thérapeutique." Dr. G. B. Duchenne, Paris, 1855.

"A Treatise on Medical Electricity." By J. Althaus, M.D. London, 1870.

"Lectures on the Clinical Uses of Electricity." By J. Russell Reynolds, M.D., F.R.S. London, 1871.

And various numbers of "Practitioner," "Lancet," etc.

P R E F A C E .

THIS small volume is intended to be a guide for the medical employment of Electricity. The author has thought that a concise and practical work, embracing the opinions of the best authorities on the subject up to the present date, would be acceptable.

The recent improvements in the apparatus used, the modern researches in electro-physiology and pathology, and the important relation Electricity holds to most nervous diseases, call for some skill on the part of the medical practitioner ; as well to protect himself, as a caution against quacks and charlatans.

Electricity, either derived from Galvanism

or Electro-magnetism, is now recognised by the most enlightened of the profession. It is, of all others, the most natural applied remedy, and is capable of effecting, in itself, results which are more surprising than most medical men will credit; while, as an auxiliary to other well-known means of treatment, it is not to be ignored.

Hence, a knowledge of medical electrical batteries, their proper mode of use, electro-physiology, &c., are as much required as any other branch of medical or surgical knowledge.

GEO. DENNISTON POWELL.

76, UPPER LEESON-STREET, DUBLIN.

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ERRATUM.

Page 67, line 4, for "Dr. Spencer of Wells," read Dr. Spencer Wells.

CHAPTER I.

INTRODUCTION.

THE chief reasons why Electricity, as a remedy, has not advanced to a more general use among medical men are, that the theory of its application and administration has not been based on sound physiological reasoning; and the numerous apparatuses have been clumsy, unmanageable, and not portable. These objections have now been removed, and I think it will be plain to all that we have in our hands a means of cure, wonderful and astonishing in its results, and applicable to diseases hitherto deemed incurable.

It is to be feared that the general opinion entertained by many medical men, is that of the late Doctor Neligan (*vide Neligan's Medicines*, seventh edition, edited by Professor Macnamara, page 572), viz., that "*The different forms of electricity may in general be indifferently applied.*" And in a former edition, "I regard

the stimulant action of magnetic electricity, so to say, as its active principle." Any one who has studied the subject will, I think, come to the conclusion that the different forms of electricity *are something more* than stimulant, "and that they all *may not* be *indifferently applied*." One class of cases requiring a certain form of the agent to be employed. In fact, a good medical battery may be compared to a surgeon's case of instruments. It is not the instrument itself that gives relief, but it is the skill of the operator in using and deciding on the instrument he employs.

Doctor Garratt observes, "Very often the question still arises in effect, Is medical electricity an art as well as a science? Is it a tangible remedy that in certain cases and conditions can work a lasting, permanent cure? If simply holding two *handles*, electrodes of an active battery respectively in the two hands of the patient—or where one is thus held, the other is somewhere applied over the head, body, or limbs—or the patient is to be *shocked*, no matter how—evidently but very little skill is demanded in the applications of electricity, and scarcely could it be termed an art."

"Medical electricity is both—a science and an art." The battery to be employed, and the *mode* in which it is to be applied to the human

body or limbs, therefore, has an all-important bearing upon the results. Indeed it is only by this intelligible discrimination in selecting the *cases*, the *stages* of the affection, the *form* of the electricity, and the *method of its application*, that any marked and uniform success can possibly be expected.

There can be no doubt that by the empirical use of electricity some accidental and truly wonderful results have been obtained, but with very many failures, and not a few truly injurious effects. On the other hand, we know that by observing rules and methods, that the nerves and organs, under certain circumstances, can be called into natural action more certainly and more thoroughly by means of electricity than by any other known agency or remedy. In fact, we are able, by merely varying the form of electricity, or the mode of application, to arouse or to allay their vital power; to diminish or increase their true functional action. Thus, while we would not claim for electricity a *cure all*, we do insist that it is one of our most valuable aids in certain diagnoses, and one of our most controllable and precious remedies, as well as a most powerful aid to other well known remedies.

For remedial purposes, we have three classes of instruments, viz., the Electric (friction)

Machine, the galvanic battery, and the induction apparatus; these should be chosen for their action, and the form of the element they respectively produce.

By the Electrical Machine, the current evolved is of great intensity, with but feeble quantity. The ordinary Plate Machine is the best for this form; it should measure at least twenty inches. The room for operating should be dry and warm, and everything connected with the apparatus must be kept perfectly neat, clean, and dry.

Formerly this form of electricity was much used by Dr. Golding Bird and Dr. Gull in Guy's Hospital, but is very rarely used in the present day. There is no doubt that by placing several persons suffering from neuralgia and nervous pain upon an insulating stool, and keeping them charged with positive electricity for some time; that the invariable result is a relief of pain at the time, and for some time afterwards, and Dr. C. B. Radcliffe believes it will be necessary to return to this original mode of using electricity as a therapeutic agent. The discharging rods and Leydon jar are necessary appendages to the electrical machine.

In order to use frictional electricity we require an insulating stool and chair, or, if the

patient be in bed, to place the feet of the *bedstead* posts in thick glass cups. The patient so placed, can be positively electrified by connecting him with the prime conductor, or negatively by the rubber connexion by means of the long discharger, or by means of the chain, or by a large copper wire tipped with balls. By a steady and smart turning of the machine the patient can be kept in this state for half an hour together, notwithstanding the insensible discharge that is constantly going on in the air. In the dark, this phenomenon is visible at the tips of the hairs and every other prominent angle of the body, and will even emit sparks if approached by a conductor.

Drawing sparks from the back of a cat is easily done in dry frosty weather, particularly if she be near the fire, by smoothing the fur with a piece of warm dry silk, and then brushing the fur gently in the wrong direction, when she will let you know she does not like it. These sparks have an in-working at the moist roots of the hair, and are of very minute quantity, but of very great intensity.

The sensations experienced when the body is made part of an electrical circuit, through which a Leyden phial is discharged, is too universally known to need description.

A small charge determined down the spine

generally causes a person to fall to the ground; the discharge of a powerful battery in the same direction would probably prove fatal. A discharge is instantaneous, but if the two electricities be constantly renewed, one of the bodies deriving from any source a continuous supply of positive, and the other one a like supply of negative, electricity, there will be, of course, a continuous neutralisation produced either through the air with sparks, or through a conductor. This state is called the electric current.

The passage of a succession of sparks produce much the same effect *locally* as would a gentle voltaic current. The effect of these sparks acts as a stimulus of a very peculiar kind, because, as Dr. Golding Bird says, besides the simple discharge, there probably is accumulated and *localized* in the flesh positive electricity, at and near the spot where the sparks leave the body, which is thus maintained in wavering density. The skin soon becomes red, which shows its effects on the capillary vessels and at the roots of the hairs. The chemical action of frictional electricity is very feeble; great intensity with little quantity; while the voltaic pile will yield an enormous *quantity* of electricity but with feeble *intensity*, and is, therefore, the most powerful in producing chemical decompositions.

Faraday calculated that it would require a Leyden battery to be charged by 800,000 turns of a powerful plate machine to decompose a single grain of water, which, by a Groves' or Daniell's battery can be done in a few seconds.

Voltaic Electricity has been compared to steam rising quietly from an open boiler, while frictional electricity is the high pressure steam of a locomotive. Lightning is the spark or discharge of electricity of very high tension.

GALVANIC ELECTRICITY.

When the youthful pupil of Galvani accidentally brought the legs of a dead frog into an electric current, he witnessed the manifestation of a new force. Neither he who first saw the phenomena, nor they who afterwards repeated the experiments, had the remotest idea that the things they thought so curious were, in fact, only the germs of extraordinary discoveries. If these first manipulators in current electricity could not look *forward* to the stupendous results now achieved by its aid, it is almost equally difficult for us to look back upon their origin. We whose statues and ornaments are produced by electric agency, whose bells are rung by its aid, who sees rocks blasted, and the obstructions in ports and rivers removed by its instrumen-

tality, and whose thoughts can be conveyed, as it were, instantaneously, thousands of miles over rocky chains, desert wastes, and all but fathomless oceans, by the same wondrous power, even we can hardly realize that all this is to be traced to the accidental, perhaps mischievous, freak of a doctor's pupil.

Galvanism or Voltaic Electricity is produced by a certain chemical action. The most simple example is shown by merely enclosing two different clean metals on each surface of the tongue, when a current is instantly established even to be felt, as by enclosing the tongue between a penny and half-a crown. When two metals are placed in contact direct, or by means of a connecting wire, and when these are placed in a liquid, or liquids, capable of acting upon the one more than the other, then that peculiar electricity is formed that is termed *Voltaic Electricity*, *Galvanic Electricity*, or *Galvanism*. The original pile for producing this current was devised by Dr. Volta an Italian, owing to the interpretation which this celebrated philosopher gave to the marvellous experiment of his contemporary, Dr. Luigi Galvani, of Bologna, namely, that a frog undergoes a violent agitation when one of its nerves, being exposed, is touched with one metal, and at the same time its muscles are touched with another

metal, while the two metals themselves are in contact.

Volta and most philosophers since him, have supposed that the liberation of the current was entirely due to the *contact* of the two different kinds of metals, whilst the liquid between them plays merely the part of a conductor. To prove this he invented his pile, and hence the term Voltaic electricity. But it has since been proved by Sir H. Davy, Becquerel, De La Rive, and Faraday, that the real source of the electricity is not from simple contact, but from the chemical action of two heterogeneous bodies ; that contact is a condition most frequently necessary but not always absolutely indispensable for the manifestation of electricity ; that Voltaic or otherwise called Galvanic Electricity, may be produced by any chemical action ; not only by the action of some liquid upon a solid, but likewise by the action of two or more dissimilar liquids upon each other, or even by gases acting upon gases, or liquids, or solids. All agreed then, as now, that the action produced upon the frog was due to the action of electricity ; and as Galvani was the first discoverer of the phenomena, it is termed Galvanic, and the science concerned in it is called Galvanism. But to the pile, says De La Rive, must remain the name of its illustrious author, Voltaic apparatus.

—all *moist* batteries, and the so-called dry batteries are termed Voltaic, and provide only a primary current of electricity. Wet batteries are called Galvanic; and from these two sources are derived all primary currents of electricity, which are termed Galvanic in contradistinction to *Faradaism*.

The original voltaic pile was in the shape of an upright column formed of discs of copper and zinc, with pieces of cloth between, well moistened with water or acidulated water. This pile is found to be charged with negative electricity at its lower extremity, which is copper, and with positive electricity at its upper, which is zinc. No matter what position this pile remains in, the current will always be the same, namely, the zinc the positive, and the copper the negative. But here let me call especial attention to the fact that this is exactly the reverse in all liquid compound batteries, as in Daniell's, for then the copper is the positive, and the zinc the negative; but this can be easily explained: from these facts not being remembered a great deal of confusion is likely to occur.

Volta's dry pile is of much the same construction as the moist, only sheets of paper are covered on one side with tin foils, which answers in the place of zinc, and on the other a solution of manganese is pasted on, the paper in this case

gathers its moisture from the atmosphere, and is its acting agent.

The current derived from these piles are variable. The copper in a short time being covered with hydrogen, together with oxide of zinc; from the decomposition of sulphate of zinc, while the zinc discs are also loaded with their own oxide. This was a great inconvenience as the current could never be relied on. To avoid this trouble Cruikshank proposed to substitute a trough of baked wood, divided into cells, in which were inserted rectangular plates of zinc and copper, and to be filled with acidulated water; but still this form of battery was subject to great inconveniences and irregularities, though it was with it the splendid discoveries of Davy and Faraday were effected. Various improvements and alterations were from time to time carried out; thus we have the Wollaston battery, and that of Berzelious, Becquerel and Gassiot, until Daniell invented his battery, which is of all others the most constant and even working galvanic battery known, and for medical purposes (as improved) is invaluable, particularly for the so-called *constant galvanic current*.

CHAPTER II.

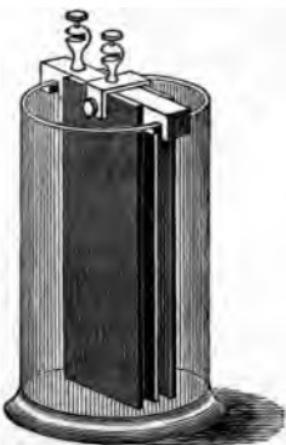
GALVANIC BATTERIES.

Daniel's Batteries.—The original battery (*Fig. 1*) consists of a copper cylinder for the negative element, in which is placed a cylinder

Fig. 1.



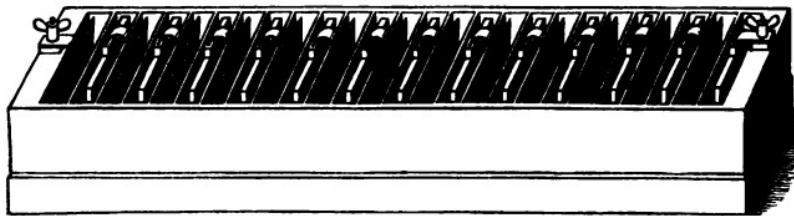
Fig. 3.



of porous earthenware, and in this a zinc rod, which is the positive element. Two exciting solutions are required for this battery, one a

saturated solution of sulphate of copper, and the other a solution of sulphuric acid and water, (7 parts water to 1 part acid). The solution of copper is placed in the copper cylinder, and the diluted sulphuric acid in the porous cylinder. The porous cylinder keeps the two solutions separate, and at the same time allows the electric current to pass through its sides. Binding screws are attached to the zinc rod and the copper cylinder, and these form the two electrodes, and any number of these can be joined together according to the power required.

Fig. 2.



I am in the habit of using a modification of this battery (*Fig. 2*). It consists of a wooden trough divided into twelve compartments, the interior of which is well-coated with marine glue.

The compartments are separated by alternate partitions of slate and porous plates of half-baked earthenware, the zinc and copper plates being connected together by a strap of copper,

and suspended across the slate partitions, thus allowing no action to take place between the two metals, except through the porous plate. The cell in which the copper plate rests is charged with a strong solution of sulphate of copper, and that in which the zinc plate rests with plain water only.

The plates so arranged and battery charged, will be brought into action as soon as the copper solution has saturated through the porous partition, and it has the advantage of producing a strong steady current, and certainly the best in my opinion for Electrolysis, or where a constant steady current is required.

A battery of this description has been known to remain in use for over eighteen months without even the plates being cleaned, it being only necessary to add a little water and a few crystals of sulphate of copper occasionally to the solution, while any power can be obtained that may be necessary. To carry it about from place to place it is only necessary to draw off a little of the water and the solution from the cells.

A similar form of battery is in use by the Electric Telegraph Company, and in most of the London and continental hospitals.

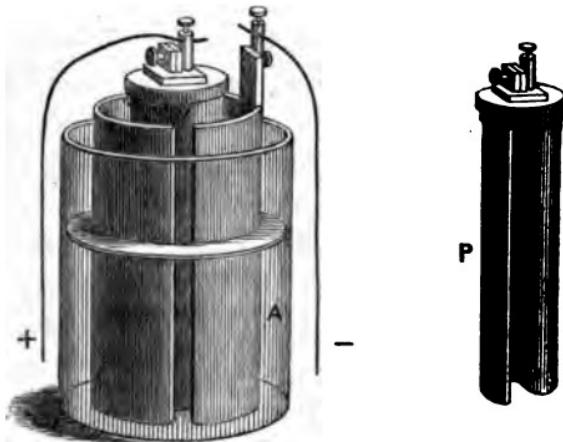
A battery known as the "Pile Marie Davy," in which sulphate of mercury and carbon elec-

trodes are substituted for the sulphate of copper, and copper electrodes of the Daniell's battery, was exhibited at the International Exhibition of 1862 by J. A. Deleuil of Paris. This new form is clean and constant, but it is weaker than Daniell's cell; it has considerable inherent resistance, and is expensive in the first instance. It is used to some extent in France for telegraphic purposes, and also is much in use for working coils. (See Ladd's Electro Magnetic Battery).

Smee's Battery (*Fig. 3*) is the cleanest, and one of the most permanent and economical arrangements we know of. This is arranged in a quart or half gallon glass jar, by nearly filling it with water acidulated with one-tenth or one-fifteenth part of sulphuric acid. Into this are plunged two flat square plates of zinc, say four by six inches, and one-half inch thick, and coated with mercury, which are suspended from the top. Between these there is arranged the thin plate of platinum or platinized silver. This battery can remain in working order for a month—but if much used should be looked after once a week; that is, the zinc plates should be newly coated with quicksilver, and if that is well attended to it will wear a year or more. The principal use we find for it is for working some description of induction coils.

Grove's Nitric Acid Battery (Fig. 4).—This is the most powerful that has been constructed; the elements are platinum for the negative, and zinc for the positive. This battery requires a containing vessel to hold the entire arrangement, and an inner cell to hold the platinum plate only. This inner cell, like Daniel's battery, must be porous earthenware, which, when wetted, will admit the passage of the galvanic

Fig. 4.



current through its sides, but will not allow the exciting fluids to mingle. When the zinc plate is placed in the containing jar, the porous cell is to be put between the upright portions of the zinc, and the platinum plate is then put into the porous cell. The zinc plate is usually made out of a long slip bent up in the form of

the letter **U**, by which means the zinc is brought opposite to each side of the platinum plate. But it is more advantageous, instead of bending a long slip of zinc, to employ three shorter pieces. One piece to be put at the bottom of the containing jar, and two other pieces on it, this forms the two vertical plates. This is less expensive to make, and more economical in use. A binding screw attached to the zinc plate and one to the platinum, form the two electrodes. Two different exciting fluids are required for this battery, strong nitric acid for the platinum, and diluted sulphuric acid for the zinc. This is a most intense battery, and is useful for rapid decomposing purposes, as for the Galvanic cautery, coagulation of blood in aneurisms, dissolution of urinary calculi, &c.

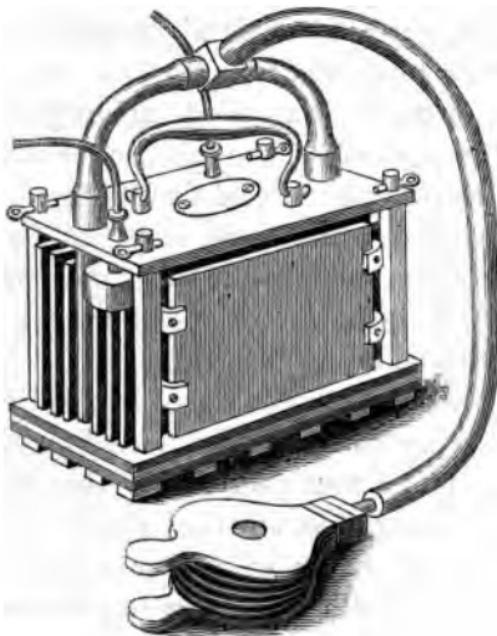
Bunsen's Battery differs but little from *Grove's*, only carbon is substituted for platinum. It being found that platinum is more negative than copper, that is, still less acted on by the liquid; so is carbon still more negative than platinum, and also being very much cheaper.

Grenet's Battery (*Fig. 5*) is devised on this principle, and for cauterising purposes is the best known. It is made expressly for the purpose of generating and maintaining electric heat which it does in a high degree.

The cost of this apparatus complete, with

conductors, cauterizer, &c., is about £6 10s., or in Paris 160 francs; for surgeons' use it is invaluable. It is composed of some six carbon plates, and eight plates of hammered zinc amalgamated with quicksilver, each of which is about six inches square, and adjusted close together

Fig. 5.



in a frame work of hard rubber; all the zines being connected as one folded plate, and all the carbons are likewise connected together as one; hence it acts as but one grand element.

A hard wood box lined with sheet lead, and

having some three gallons' capacity is made to receive it. Into this bath-box is poured six quarts of water and two pounds of clear sulphuric acid, gradually added and mixed with a strip of glass. Then add one pound of coarsely powdered bichromate of Potassa, stir well until dissolved and cooled, when all is ready for the operation of cauterization, the conductors and the chosen canterizer being selected and adjusted, the battery is to be lifted gently into the bichromate solution; and the instant contact is made, the cauterizer becomes brilliantly red hot. The degree of heat is regulated by screwing fast only one of the conductors, merely holding the other in contact, so as to quickly remove it if necessary, or more lightly touching it to the binding screw. As soon as the operation is over—whether five, ten, or thirty minutes—the battery should be taken out of the bath, and immediately rinsed in plain water. The zinc plates should also be re-amalgamated after each time of using. The solution should be left in the box for future use.

After this battery has been in use a few times the heat is lessened; in this case, (or if a more severe operation is anticipated), fix on the elastic tubes and adjust the bellows, so that an assistant can force air to the bottom of the battery, which is perforated from an air-chamber. The air is

thus forced down and up through the solution, aerating it, and causing a more rapid oxidation. Thus any degree of heat, even a white heat, may be obtained, regulated, and maintained for nearly an hour. This beautiful battery can be obtained from M. Grenett, 14, Rue de Castiglione, à Paris.

Fig. 6.



Pulvermacher's Chain Battery (Fig. 6).—This very popular battery as lately improved is very useful in certain cases where the continuous current is indicated. It is composed of a hollow tube of magnesium nearly an inch in length, over which is a spiral coil of copper, these are connected together by flattened copper, and any number of these can be used according to the power required. These bat-

teries form a perfect miniature Voltaic pile, and is very lasting in the current it gives. A few elements of this battery will decompose water, or chemical substances, even though the current passes through several persons, and will deflect a galvanometer to its full extent. The exciting fluid being diluted vinegar. There is sufficient power and intensity without the great heat and chemical action of the larger batteries. By the employment of the metal magnesium it produces a double electro motive force, the specific gravity being five times that of zinc, but what is more remarkable still, water will alone excite it, or the humidity of the body (perspiration), excites it equal to the power obtained by the action of vinegar on zinc, with which the old Pulvermacher's Chain Batteries were constructed. The chain batteries are excited by drawing them slowly through vinegar from one end to the other until every part becomes charged with the fluid, it is then applied to the part required—as "apply the gold buckle over the spine and the silver over the seat of disease." As a rule it is advisable to apply the copper or negative pole to the nervous centre, and the white or positive pole to the seat of disease. A rapid succession of shocks can be produced with this battery by interposing a spiral spring of copper enclosed in a glass cylinder between two

chains, the spring being shaken and made to vibrate. The greatest energy is seen at the white end or positive pole; this is the alkaline, resolvent, and hydrogen pole, and frequently the skin under it is destroyed, producing a small eschar. These eschars are, however, by no means necessary, and when seen the vinegar should be diluted, or a small fine piece of moist flannel interposed between the pole and the skin, so as to avoid their production.

Many medical men, beside myself, have had great success in the treatment of obstinate Neuralgias, Rheumatic and Paralytic Affections of a certain class with these batteries or combined with the induced (Faradaic) current.

Mr. Pulvermacher has also invented light bands of copper and zinc interwoven on the same principle as his batteries, and which are intended to be constantly worn over a diseased part as a paralysed limb, &c., these he terms Galvano Pilin or chain bands.

Having been charged with diluted vinegar they are applied in the same manner as the chain batteries, and the insensible perspiration of the body will keep up a constant current of electricity so long as they remain in contact with the body. They are of great use as an aid to other treatment by electricity, &c., and will tend to increase the temperature of a limb,

&c., when requisite; in cases of general weakness, constipation of the bowels, torpid liver, kidneys, &c., I have seen them do great good in connexion with other means.

Several of these bands can be joined together (called "*The Combined Electric Bands*") where we wish all the principle nervous centres to be embraced. Thus, for instance, a set of bands may be combined, so as to connect one of them, intended to be worn along the spine, with another applied so as to surround a portion of the throat, and at the lower extremity, with a third enveloping part of the trunk. Thus we may furnish a supply of electricity to the functional organs, so as to act simultaneously upon the principal nervous centres, and upon the vascular system as is often requisite in wandering and chronic *Rheumatism*, *Gout*, *General Debility*, *General or Central Paralysis*, *Functional Disorders*, and also in the premonitory stage of cholera and collapse.

Though these chain bands and batteries are generally used, when the *mild continuous current* is required, we can also produce from them very *strong continuous* and *intermittent currents*, though they are not so often required as the constant mild current.

Courant Electrique Tipsus, are papers made of copper and zinc foil about one inch in width

and one-eighth of an inch in length; they are made in lengths of several inches on gummed paper, and are intended to be applied to the part affected much in the same way as a plaster, as in neuralgia of the face, affections of the optic nerve, &c. My own experience does not lead me to place much reliance on them, as the quantity of galvanism evolved must be very feeble. They are, however, on the Continent much recommended, and even in Great Britain I have seen them ordered. They are made by M. Courant, 31, Rue Louis-le Grande, à Paris.

Many pseudo galvanic contrivances are made and largely advertised by quacks and impostors, pretended galvanic or electric appliances intended to be worn on the body, in the form of belts, &c., and for which the vendors claim the peculiar merit of generating electricity of a very mild character, so mild, indeed, that no testing instrument could be found sufficiently sensitive to detect the slightest trace or indication of this marvellous agent!

CHAPTER III.

VOLTAIC ELECTRICITY.

In using Voltaic Electricity as a therapeutic, we require to bear in mind certain facts relating to conduction and insulation, the direction of the current, and also the two very important and distinctive characteristics of quantity and intensity.

1. *Conductors, Non-Conductors or Insulators.*

Most bodies and metals in particular are conductors, while amber, wax, hard-baked wood, resin, gum lac, silk, oil, India rubber, gutta percha, and other substances are called insulators. The earth is our largest conductor; the atmosphere, when dry, is our largest insulator, the diamond is the most perfect insulator, while pure copper is nearly a perfect conductor.

Faraday thinks that conduction and insulation are only extreme degrees of one common

condition; that they are the same in principle and in action, except that in conduction an effect common to both is raised to the highest degree; whereas in insulation it occurs in the best cases only in an almost insensible quantity. Thus, water is a conductor, but dry ice is a good insulator; glass is considered a good insulator, but if it is damp or drawn out into a fine rod, or is heated to redness it becomes a good conductor. The conductivity of bodies will not alone depend upon their chemical nature, but also upon their form. Thus, if an electric current of a given quantity and intensity is made to pass through several wires of different lengths, of the same metal and the same diameter, we will observe that the current loses power in proportion to the wire tested, and also if a current is made to pass through wires of the same metal and the same length, but of different diameter, the power is greater in proportion to the diameter of the wires, indeed there are no absolutely perfect conductors of electricity, as all bodies will offer a greater or less resistance. The human living body conducts an electric current from ten to twenty times better than cold water; this is supposed to be due to the warm salt water it contains, and the cellular arrangement of the living *organism*, which being separated by the thinnest

membrane, being provided with nerves, and have a tendency to electrical action.

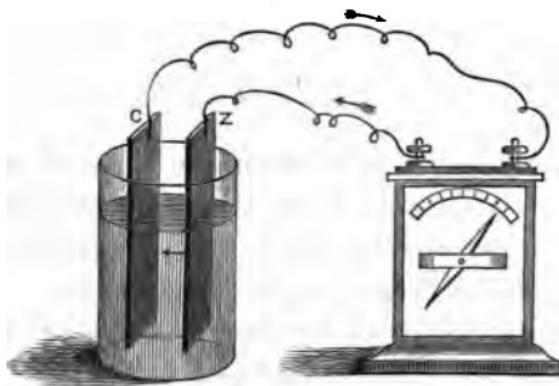
The epidermis offers the greatest resistance to all currents of electricity; but this can, to a great extent, be overcome by using *wet* electrodes. There is a great difference between the conductivity of different persons, and of the same person at different times. In a group of persons a single one may be struck by lightning, while all the rest will escape. This can not be satisfactorily explained. Persons who perspire freely are more liable to be struck than those who do not.

2. *The Direction of the Current.*

Much confusion exists in the mind of many persons with reference to the terms the Positive and Negative *elements* of a battery, and the Positive and Negative *poles* of a battery. This is readily dissipated by observing that the term *element* is applied to that part of the plate of a battery that is *within* the exciting fluid, such being the active part of the plate, and the term *pole* to that part of the plate that is *outside* the fluid, and which becomes a conductor only; the term *Positive* is intended to signify that from whence the current proceeds, while the *Negative* signifies that which the current enters.

The metal that is *most attacked* determines the direction of the current, and this is the positive (or plus +), while the metal that is *least attacked* is the negative (or minus -), and this is the case in all dry batteries, or Voltaic, of which Pulvermacher's is a good example, as the zinc end is the positive and the copper the negative. But in the case of the moist batteries (as in Daniell's) the case is different. We must bear in mind that *the Positive current travels from the zinc through the liquid to the copper* (see *Fig. 7*),

Fig. 7.



and then from the copper to the zinc of the next pair, and then through that liquid to the copper there contained, and so on through all the series of pairs in the cups or jars of the compound battery; so that the copper is *always* the positive pole in these constant batteries, and the zinc

the negative. (See De la Rive, vol. ii. pp. 662, 663, English trans.) Therefore, in the case of Daniell's and Berzelius' batteries the positive pole will be formed by the copper; in Grove's or Smee's batteries by the platinum or silver; in Bunsen's battery by the carbon, while the zincs form the negative pole in each of these batteries.

3. *Quantity and Intensity.*

These very distinct and important characteristics must never be unheeded or confounded, as they have most distinct physiological effects. The quantity of a current is in proportion to the size of the pair; the intensity of the current is in proportion to the number of pairs. Mr. L. Clark (Proceedings of the Royal Institution, March 15th, 1861) points out that the expression *intensity*, as ordinarily used, involves two perfectly distinct qualities, viz.: *tension* or *electromotive force*, or *power of overcoming resistance*. All the most striking properties of electricity, such as the decomposition of water and salts, the combustion of metals, the deflection of the galvanometer, the attraction of the electro-magnet, and the physiological effects of the current, are really dependant, as regards their magnitude and energy, solely on the

quantity of electricity passing. Their greater energy, when the tension is increased, is an indirect effect due not to that tension but to the increased quantity which passes in a given time by reason of the increased tension. A galvanometer consisting of a few turns only of thick copper wire is deflected as powerfully by *one* cell of a battery (say Daniell's) as by 6, or even 600; provided the cells are all of the same size. For the action in each cell is simply to urge forward the quantity arising from the first pair. A galvanometer with many hundred turns of fine wire will receive as great a deflection with a battery formed of a *small* strip of zinc inserted into a silver thimble filled with diluted sulphuric acid, (as exemplified by an experiment made some time ago by Mr. L. Clark in working through the two Atlantic cables from Ireland to Newfoundland and back again to Ireland), as with one of twenty square feet of surface. Quantity is regulated and limited by the size of the plates, the larger the plates the greater the quantity of electricity produced. The quantity evolved in a given time by a pair of plates depends on the total amount of decomposition produced. The chemical action remains the same; whether the plates are large or small no greater quantity of electricity would be measured by a galvanometer with 1,000 pairs

than with one pair. In every case the deflection is dependent solely on the *quantity* of the electricity passing through the instrument without reference to its intensity.

The ignition of metals is a phenomenon dependant on quantity and not on intensity; thus, one cell of a battery will ignite a certain length of platinum wire, but by the addition of two or three more cells two or three times the length of the wire will be ignited, the quantity passing in the greater length being under the higher tension, precisely the same as in the original length. In this sense is to be understood Faraday's remark, "that the same quantity of electricity which would ignite an inch of wire would ignite a foot or a mile of the same wire." A battery of two or three cells which will readily fuse platinum wire, produces no shock, because, although the *quantity* of electricity is abundant, the tension is low; on the other hand, a battery of a greater number of pairs of small plates may give an intolerable shock to the system, though from its deficiency in quantity it may have scarcely any power to fuse platinum wire.

In using a single cell (as a Smees) in working an electro-magnetic coil we get the full *quantity current*; but by adding a certain number of cells we may probably produce such chemical action as will burn up or fuse the

wire the coil is made of, as was supposed to be the case with the first Atlantic cable.

Electric heat is produced in the same way as electric light, by rapid or extensive chemical action, we require only *quantity* with very little intensity; thus Bunsen's or Grove's or Grenet's battery will produce instant effects, which is used for all the purposes of a cautery, &c.—(See Grenet's battery).

CHAPTER IV.

APPARATUS FOR THE PRODUCTION OF THE INDUCED CURRENTS.

ELECTRO Magnetism, Galvano Magnetism, or Magneto Electricity are terms to denote that form of electricity obtained by the now well-known laws of induction.

Professor Faraday was the inventor of this class of apparatus, though not the first discoverer, as the experiments and discoveries of Oersted of Copenhagen, Ampere, Schweigger, and others led the way to this form of electricity produced by the induction coil, invented by Faraday, and hence all these currents are now spoken of as *Faradaic* (pronounced *fara-dic*), and this species of electricity, *Faradaic Electricity*. Faradaic machines and Faradaic currents are terms used to denote certain induction currents from other induction currents, and is called *Electro Magnetic*—and produced by the Electro Magnetic Machine, and also an

induced current produced by permanent magnets, and called Magneto Electric.

The application of such currents is termed *faradization* by Duchenne (de Bologne) and others, as a tribute of esteem for this great philosopher, and is now known all over the world as such.

An *Electro Magnetic Machine suitable for medical uses should furnish two currents, viz.: the primary or extra current induced by the thick wire; and the secondary current, or the current induced in the second wire, which is long and fine, ordinarily known as the induction coil, for description of which see any good text book of electricity.*

According to Duchenne there is a considerable physiological difference in the action of the primary current (called by him current of the first order), and of the secondary current (called by him current of the second order). He says the primary current acts chiefly on the contractile power of the muscles, and the secondary on the sentient nerves. Duchenne attributes this action to a special elective power in each of the currents, but it is more probably due to difference of tension that exists in each current, a view which was first suggested by M. Becquerel.

There are a great variety of these Electro

Magnetic Machines. I have seen innumerable samples of them in France, Germany, the United States, and elsewhere; and the principle of most of them are the same, namely, their property of obtaining in a greater or less degree, *an intermitting and alternating current of intensity*, simply from a single or compound galvanic battery of great relative quantity: some of these are good, others are not.

Among the best Medical Electro Magnetic Batteries that are to be found in Europe are Legendre and Morin's, Stohrer's, Duchenne's, Ladd's Marie Davy arrangement, Ruhmkorff's and others.

Ladd's Electro Magnetic Coil (Fig. 8) is the best battery I am acquainted with; it is highly recommended and spoken of by several London electricians, and it fulfils in a high degree all the requisites of a good Electro Magnetic Battery, having the primary and secondary currents distinct, being very portable (about the size of an ordinary 8vo. volume). No acids requisite, not being easily put out of order, and very simple in its management. It is shown in fig. 8.

The Electrometer is a sulphate of mercury battery, *i.e.*, composed of a carbon dish, over which is a plate of zinc, and is excited by a little sulphate of mercury and water which has

been chosen for its extreme cleanliness, and high electro motive force. The apparatus when closed resembles a small book with a clasp. On the left hand side of the book is a small door, which, upon being opened, exposes the sulphate

Fig. 8.



of mercury battery. The tray is made of ebonite; within this is a cell of carbon cut out of a solid block, this is lined with a piece of cloth or lint, and upon this is placed a slab of

zinc, a piece of which is bent up and faced with platinum. There is also a copper connecting piece for the carbon cell. On the right hand side of the tray, the poles, vibrating spring, etc., are placed.

To excite the battery a sufficient quantity of sulphate of mercury is placed on the carbon tray to cover it over and make an even surface; the lint is placed above this and left sufficiently large to turn up at the sides so as to prevent contact between the zinc and carbon; about a teaspoonful of water is then poured on it, and the zinc plate placed on the lint; the tray is now put back into the box and closed. The battery is now in circuit with the primary wire of the coil; the spring must next be adjusted by the eccentric button, which should be gently turned round until the vibrations show that the battery is in action; by turning the button back a little, the vibrations are diminished in frequency. On either side of the vibrating spring will be perceived two nuts with holes through them, those on the left marked P + and P -, those on the right S + and S - ; P + means the positive pole of the primary wire, and P - the negative pole of the primary wire; S + signifies the positive pole of the secondary or finer wire; S - the negative pole of the same wire. If a very gentle current be desired the

copper pegs of the conducting wires must be inserted into P + and P - respectively, and upon holding the conductors in the hands the physiological effects are scarcely perceptible; to increase these the brass handle in front of the box to the right of the clasp is gradually drawn out, and the soft iron core contained in the centre of the coils is gradually exposed and magnetized, increasing the strength of the induced current; on pushing back the brass tube and inserting the pegs of the conducting wires into the nuts S + and S -, the current from the secondary wire, which is more powerful than that from the primary wire, is obtained. If now magnetic induction be added to galvano induction by gradually drawing out the brass tube, the current becomes by degrees so powerful as to be unbearable; thus with this little battery any *requisite* amount of power may be obtained.

If it is in regular daily use the carbon cell will have to be cleaned about once a week, the lint should be taken out and well washed, so as to remove all the yellow deposit; the carbon then rinsed out with fresh water, and the under surface of the zinc well washed; the lint is now replaced, and the battery is ready to be re-excited; the process of cleaning need not take more than two or three minutes.

The form of Voltaic battery in which sulphate of mercury and carbon electrodes are substituted for the sulphate of copper, and copper electrodes of the Daniell's battery, is known as the "Pile Marie Davy." An arrangement of many hundred cells has been constructed by Mr. Gassiot, with which he now exhibits some beautiful experiments. The Marie Davy Battery has not the power of Daniell's, but it is clean and remarkably constant.

I have been using this battery for the past four years and find it most satisfactory for all the purposes of electro magnetism, with many advantages not possessed by other apparatuses. It is manufactured by W. Ladd the eminent scientific instrument maker, Beak-street, Regent-street, London, W.

The apparatus of Legendre and Morin of Paris, is a neat, portable, and most efficient arrangement. The battery is a compound one, composed of thirty cups composed of carbon, which forms one pole, and contains zinc which forms the other pole, and the charge is composed of forty-nine parts of water to one of nitric acid.

One of these cups is sufficient to put into action a most powerful induction coil. Two or more cups may thus be used; they yield a

true primary current of so much quantity and intensity for chemical action that it rapidly reddens the skin, quickens the nerves and circulation, and warms the part or the whole person.

The acid fumes of this battery cannot escape, as the cups are closely covered with hard gutta percha. This battery will also give both the primary and secondary currents.

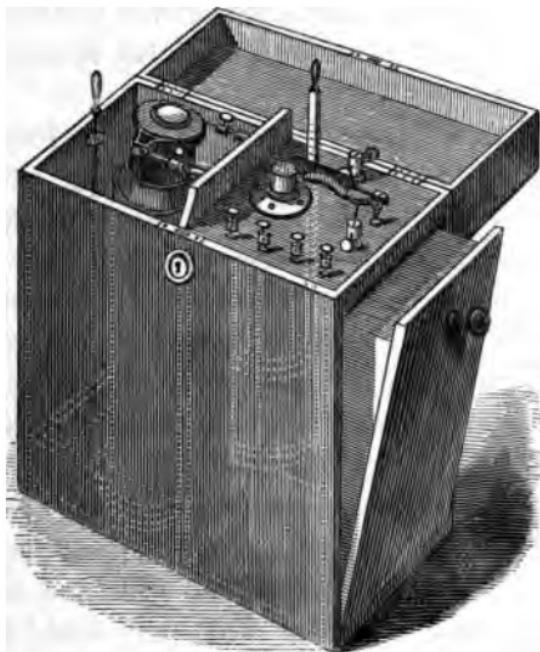
The battery of Dr. Duchenne (de Boulogne) also yields the two currents, as also that of Ruhmkorff's of Paris, which is a very small, neat and powerful battery, worked like Ladd's, with sulphate of mercury in a carbon and zinc battery.

The apparatus of Dr. Emil Stohrer's (*Fig. 9*) is well known in Great Britain, and is a very constant and powerful battery, giving the two powers it consists of, charcoal and zinc, without the use of an earthenware trough. The interior of the charcoal is filled with fine sand, which is saturated with chromic acid (concentrated) dissolved in water, and is shut with a stopper of glass. For daily and constant use this portion need only be renewed as often as the diluted sulphuric acid in the glass.

The zinc surrounds the charcoal, and is kept from contact with the same by glass insulation. Zinc and charcoal are fastened on the partition

of the apparatus by clamp screws; one is to keep the small copper plate which is pressed by a screw immediately on the partition side of the charcoal, quite at the point of contact. The glass serves as a receptacle for the diluted sulphuric acid, it is moveable vertically, and can

Fig. 9.



be fastened at any distance. This arrangement has for its purpose to bring the acid, quite or only partly, in contact with the zinc. By wholly letting down the glass it removes all effects. As the acid should take up only the undermost

third part of the glass, the apparatus can be removed with the contents without any damage.

The zinc must be kept well amalgamated: this is readily effected by laying the zinc in dilute sulphuric acid and allowing it to remain a few minutes. It should then be taken out and while wet have a few globules of mercury placed on it and then rubbed over the face and edges until it presents a uniform silvered appearance.

Stohrer's battery keeps in order from six weeks to three months, by adding a small quantity of dilute sulphuric acid, when that gets low in the glass jar.

Medical Electro Magnetic Apparatus are variously provided with a galvanic or primary battery of more or less power. The helix or coil of induction (or inductorium) also greatly varies in quality and power.

Apparatus fitted to work with Smee's battery and also Berzelius' battery (of copper cup and zinc cylinder) are to be met with, and are, no doubt, good in their way, but Ladd's and Stohrer's batteries are undoubtedly the cleanest, most portable and powerful made in this country.

MAGNETO ELECTRICITY.

Electricity and Magnetism mutually reproduce one another. Not only can iron be magnetized by a current, but a current can be obtained from a magnet. If a piece of soft iron be wrapped with insulated wire, and be magnetized by a permanent magnet, a current will be set up in the wire, whenever the magnetic state of the iron is altered by its being made to approach, or recede, from the permanent magnet. The current is but momentary; it exists only during the time the magnetic change is taking place; and the direction of the current produced by the *cessation* of magnetism will be the reverse of that set up by its production. The more rapidly the magnetic change is brought about, that is, the more promptly the soft iron armature is placed in contact with, or detached from the magnet, the greater will be the tension of the current.

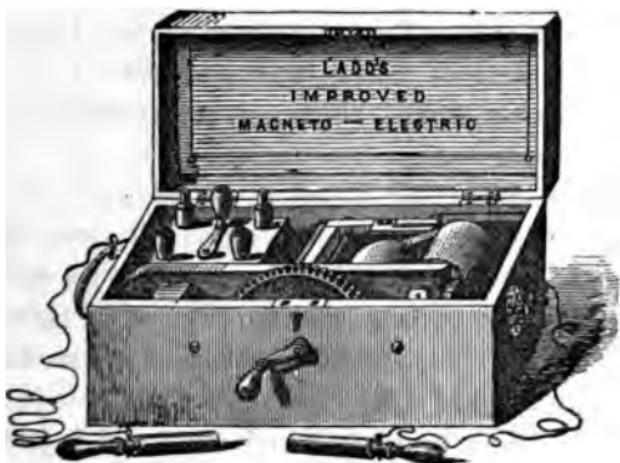
This, too, was the result of Faraday's profound researches. He found that if the poles of an ordinary horse-shoe magnet be approached by one of the ends of a copper wire, that is insulated and wound like a helix round a wooden spool, that the needle of the galvanometer that is within the circuit is immediately deflected, but soon comes again to rest. This,

he observed, was repeated also when the end of the wire was removed from the pole of the magnet, and that in the opposite direction, and then again the needle soon came to rest. This indicated that a current is produced instantaneously and in a given direction, when the wire of the helix *approaches* the pole of the magnet, and is repeated, but in the opposite direction, when the wire is *receding* from the magnet.

For producing a current of a succession of shocks, the magnet or the wire must be approached and withdrawn in quick succession. To bring this about various Magneto Electric Machines are made, a great number of which are imported from America, and many of them are perfectly useless for the scientific application of this form of electricity to medicine. Among the best and most effective, as well as convenient and economical is the arrangement of Mr. Ladd of London, shown in *Fig. 10*. The force of the shocks is regulated simply and accurately by an arrangement by which the distance of the armature from the poles of the magnet can be increased or diminished, and the noise which in the earlier machines was produced by the working together of the metallic cog-wheels, has been obviated by the substitution of discs of vulcanized rubber.

The intensity of these machines depend, first, on the size of the magnet, and whether single or compound; second, on the size of the wire that is wound round the armature, and the length of it; third, upon the nearness of the armature to the poles of the magnet, and fourthly, upon the velocity with which the wheel is turned. The current generated from

Fig. 10.



these machines at each end are alternately positive and negative, which can be shown by decomposing water, as hydrogen and oxygen will alternately appear at both poles; but an arrangement can be made by having a spring cut off on the large shaft of the armature, so as to strike an alternate cog of brass and ivory,

and thus to *intercept* one set of the shocks that make up a one-way current, leaving the other to pass to the electrodes, as a current made up of fine shocks or bits of currents, but *all in one direction*. This can be shown by the decomposition of Iodide of Potassium and starch only at one pole, so that we have an induction current with a nominal pole; but here are the positive and negative poles truly so in effect.

An Electro Magnetic Machine which has an extensive sale in Europe as well as the United States is that of Davis and Kidders of New York, and *many* of them are, no doubt, good instruments.

These Magneto Electric Machines are in general use in our hospitals and all over the country where galvanism (so-called) is resorted to, and are used in a great number of instances without knowing the effects they are intended to produce, and too often with serious injury to the patient by its indiscriminate and injudicious application. The question may be asked, can they be used in all cases where the electric treatment is indicated? Not by any means. The Magneto Electric Machines may be used for cold, lumbago, chronic rheumatism, gouty deposits and callosities, and where there is a lifeless and insensible condition; for suspended animation, and for revulsive effects; for stimulating

the bowels to action, for some cases of anæsthesia and paralysis, where there is no irritative lesion, or painful or excitable state of the nervous system, and for a rallying power generally; but it should not be long continued without more or less intermission.

The writer is of opinion that our admirably managed hospitals ought to be furnished with all the necessary electrical appliances, and that all students and pupils should be properly instructed in their modus operandi, as is now done with all other instruments.

The currents generated from the Magneto Electric apparatus is very irritating, causing irregular muscular contractions, and in cases of paralysis is apt to weaken and tire the muscular fibre when continued for any length of time, so that in all such cases it is best to rely on the Galvano or Electro Magnetic currents, which can be regulated with greater nicety, so as to meet the requirements and feelings of the patient.

These Magneto Electric Machines also are liable to get out of order more easily than the Electro Magnetic. The magnet becomes demagnetised after a time, and they also require an assistant to turn the handle (unless a clock-work arrangement is adopted).

*Difference between the Galvanic and the
Induction (Faradaic) Currents.*

The former are continuous and in one direction; but the latter are always in intermittent, and in alternate directions; "but the terminal shock is stronger than the initial shock, but when taken together they make a stronger current in that direction, hence one is called positive and the other negative, which *in effect holds* true when acting on and through living tissue;" also when water is decomposed by the galvanic current, the hydrogen always appears at the negative pole, and the oxygen at the positive pole. This is not the case when water is brought into circuit with the induced current, for then the hydrogen and oxygen appears alternately at each pole, so that the water is not at all decomposed. The same effect takes place when any chemical substance is decomposed, as by bringing a solution of Iodide of Potassium into the circuit, in the induced current the blue colour of the iodine will appear at both poles; but in the galvanic current the blue colour will only be seen at the *positive pole*.

ÆSTHESIOMETER.

This instrument was devised by Dr. Sievking as an aid in the diagnosing of certain forms of nervous disease;* it consists (see *Fig. 11*) of a square rod of brass four inches long, graduated and marked into inches and tenths of inches. At one end is a fixed point one inch long, projecting at right angles, while another similar point is made to slide along the graduated beam, much

Fig. 11.



like a shoemaker's measure. It is important the patient should not know what is intended—its object being to distinguish the distance between two points, applied at the same time at different parts of the body, and thus to determine the absolute impairment of tactile sensibility in a given case.

There are three classes of cases in which the *Æsthesioscope* may prove useful in the diagnosis:—

* See *British and Foreign Medico Chirurgical Review*, 1858, p. 280.

1. In suspected actual paralysis, to determine the amount and extent of anaesthesia.
2. As a means of diagnosis between actual paralysis of sensation and mere "subjective anaesthesia," in which case we know the tactile powers are unaltered.
3. As a means of finding out the progress of a case while under the electric treatment.

CONDUCTORS OR ELECTRODES FOR MEDICAL PURPOSES.

Several forms of conductors are required for the administration of electricity to the different organs: if it is required to act superficially on the skin it should be dried, and dried metallic electrodes employed; but if it is wished to penetrate to the deep-seated muscles, organs or nerves, the skin should be well moistened with water or acidulated water, and moistened sponges used as conductors. In stimulating a paralysed muscle a pointed metal conductor covered with moist sponge should be used, as we can then search out, and stimulate individually any particular muscle through the nerve that enters it (Remak), so that thorough anatomical knowledge is requisite, as some of the deep-seated muscles are not easy to get at.

For paralysis of sensation of the surface a

wire brush is sometimes required (*Fig. 14*), and for toothache fine wire conductors are made to penetrate a decayed tooth, &c. The electric poultice requires a large surface of metal : a piece of thin sheet silver, brass, copper, or tin will answer this purpose.

No electrode should be used a second time without being well washed ; the sponges should be well washed with soap and warm water, and then passed through a dilute solution of Liquor Sodæ Chlorinatæ.

Figures of Conductors.

Fig. 12.—Spoon-shaped Electrode.
Used for the general application of electricity.



Fig. 13.—Swivel Electrode.

The pad is metal, to be covered with wash leather or fine sponge moistened, and is useful for passing down the spine, inside the dress of ladies, and for the stomach, bowels, etc.



Fig. 14.—Faradaic Brush or Whip.



Fig. 15.—Manner of holding Duchenne's Directors.

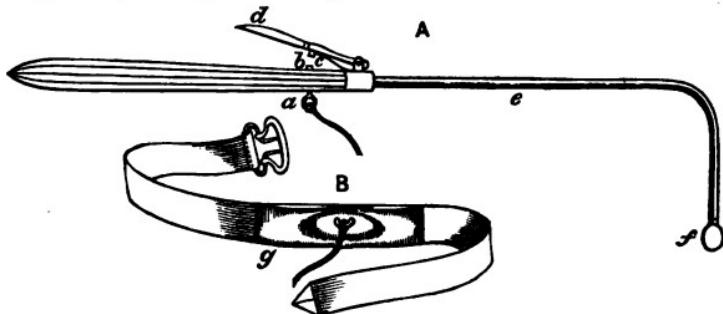


Fig. 16.—Duchenne's Directors (Rheaphores), $\frac{1}{3}$ size.



Fig. 17.—Laryngeal Electrode and Necklet (Mackenzie).

A the Laryngeal Electrode; *a* a metal ring by which the electrode is connected by a chain either with a battery or Magneto-electric Machine; *b* the extremity of a wire communicating with *a*; *c* metal point, which, when the ivory handle *d* is pressed upon touches *b*. The current then passes along the wire *e* (which is insulated in caoutchouc) to the sponge *f*. The handle of the instrument is of wood or glass. B the Necklet which the patient wears; *g* the chain by which the necklet is connected to the apparatus producing the electricity.

*Fig. 18.—Laryngeal Electrodes of Mackenzie.*

The two poles are united in the same instrument—one wire going to the ring *a*, the other to the ring *b*. The two rods are carefully isolated, so that when the little handle on the upper part of the instrument is touched the current passes between the two brass knobs.

A represents No. 2 electrode. It is useful for electrifying the surface of the vocal cords, and indirectly the thyro-arytenoid muscles, the arytenoid-*enus proprius*, and the posterior crico-arytenoid muscles. The current passes between the two knobs at *c*.

B represents No. 3 electrode. It is introduced into the larynx in such a way that the pole *a* is in contact with the vocal cord, and *b* passes into the hyoid fossa.

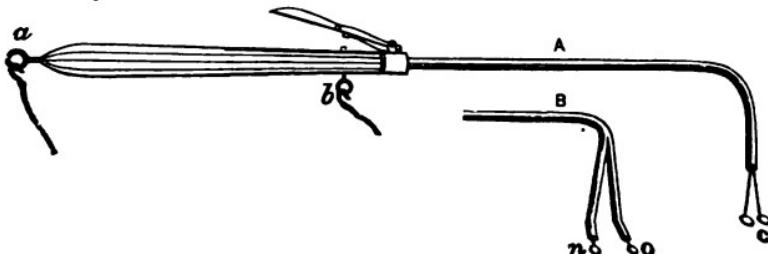


Fig. 19.—Handle Electrode for holding Galvano Cautery.

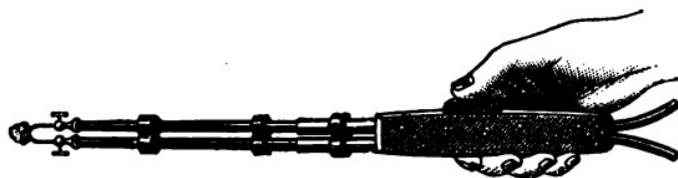


Fig. 20.—Galvano Pessary of Sir J. Y. Simpson.



CHAPTER V.

ELECTRO PHYSIOLOGY.

A THOROUGH knowledge of the physiological effects produced by the application of electricity in its different forms, to the various parts of the living body in its normal condition is necessary to enable us to form a correct notion of its value in its application to disease.

The recent discoveries and writings of Duchenne (de Bologne), Benedikt of Vienna, Radcliff, Eckhard, Shettle, Lester, Scoutellen, and others, are so numerous that a bare outline of such can only be given in a small work like this; various opinions connected with this subject are given in other portions.

The physiological effects of electricity are in part dependent on the form of the agent employed, and partly on the properties and functions of the organs submitted to its action. Thus, if the sparks from an ordinary electrical

machine (Franklinic) are applied to the skin, a sensation of pricking and pain is experienced, and if long continued the skin will become red and inflamed, and an eruption resembling urticaria produced. If the Primary or Voltaic current be employed to act on the skin; heat, redness, and inflammation is caused, and if the current be intense enough ulceration and destruction of the skin and tissues (in fact cauterization) are produced; and if the Faradaic currents (Electro Magnetic or Magneto Electric) be employed, there is a simple tingling to a sharp burning pain, varying in intensity according to the tension of the current, but no matter how high that may be, inflammation and gangrene of the parts *will not* be produced. To give another example: if the same induced current be applied to the face, by means of moist conductors, the muscles are contracted and no sensation of light produced on the retina (unless of very high tension), while with the continuous (Voltaic) current, a strong flash of light is produced, which if the current be sufficiently intense, might cause severe inflammation of the retina, or even instantaneous blindness; while the sparks produced from an electrical machine produce only an indistinct flash of light.

The quantity and intensity also have much

to do with the physiological effects. If a large quantity of electricity is used (as is the case if we employ a large number of cells of a Daniell's or Grove's battery), calorific and chemical effects are produced, causing cauterization and destruction of the tissues. If an induction current of low tension (such as is produced in the thick and short primary wire of an Electro Magnetic Machine) feeble contractions of the muscles are produced; but if this current be produced from the long and fine wire (secondary current) of sufficient intensity, it causes intense pain like a red hot iron, with strong muscular contractions, resembling violent cramps, the pain of which remains some time after.

The physiological effects caused by electricity differ also according to the mode in which it is applied to the different organs; thus, if dry metallic conductors be applied to the skin it passes off superficially, acting on the sentient nerves of the skin, but not penetrating to the muscles (provided the current be not too high); but if moistened conductors are used it penetrates to the deep-seated muscles, producing contractions to these muscles over which the electrodes are applied, or if applied over a nerve (as the median or sciatic), it stimulates and contracts all the muscles supplied by that nerve; but the electrodes require to be well pressed.

against the nerve, as the current will pass along the cellular tissue which encloses the nerve (as cellular tissue is a better conductor of electricity than the nerve), so that in this case no contraction of the muscles are produced.

The physiological effects of electricity are also determined by the special property of the organ to which it is applied. The same current which causes a flash of light when applied to the eye, will cause sounds when applied to the ear, special sense of taste when acting on the tongue, heat, &c., when applied to the skin, and muscular contractions when applied to a motor nerve; and finally the state of vitality in which the organs are at the time the electricity is applied to it, have an all important bearing on the results. Thus, in sciatica, neuralgia, tic douloureux and other forms of hyperæsthesia may be subdued by electricity, or a nerve or nerves, the energy of which may be lessened or even gone, may be restored to its normal state.

Is it not then rational to treat disease with the agent which is proved to circulate freely through every tissue of the human body, supervising their functions and controlling their natural tendencies.

The following may be considered some of the present views of Electro Physiology. We

may now regard as demonstrated in a decided manner by the researches of Matteucci and Dubois Reymond: 1st. That there exists both in the muscles and nerves of all animals a natural electricity, independent of mechanical, physical, or chemical actions, exterior or interior. 2nd. That this electricity is manifested under the form of closed currents circulating along the muscles or nerves of the animal, and of which we can collect but a very small derived portion by the assistance of our instruments. 3rd. That the presence of this free electricity is subordinate to the state of the life of the animal, and disappears with the vital force, and the laws that govern the electric state of the muscles and nerves, are those of their elements. (De la Rive).

During the state of inaction, living animal tissues are found to be capable of acting upon the gold leaf of an electroscope, and of furnishing other signs which show that the natural electricity of these tissues is characterized by high tension. (Gardine, Ahrens, Nape, Radcliffe). All parts of the body furnish signs of free positive electricity, especially when the circulation is excited, and those signs disappear under the action of cold and in rheumatic fever, &c. (Ahrens, Nape, Radcliffe).

In arterial blood fresh drawn from the body

there is a current passing from one electrode to another inserted in it, to be detected by the galvanometer, and there is none in veinous blood. (Shettle).

The coagulation of blood drawn from the body is increased in rapidity by contact with a foreign body. (Lister).

M. Scoutellen reported to the Academy of Science at Paris an account of some experiments made upon horses, previously made insensible to pain. He found that the electric positive sign, indicating the direction of the current, was constantly from the red, or arterial, to the black, or venous blood. He concludes his report by saying, that since it is demonstrated that the red blood and the black blood, in their contact through the walls of the vessels, which act as true porous vases, give stated electric reactions to the galvanometer, we must admit that, as all the parts of the body are traversed by sanguineous fluids, there must necessarily be a constant disengagement of electricity in the relaxed tissues of our bodies. Thus, each organic molecule is incessantly stimulated by the electric fluid, and thus under the influence of this excitement, all the functions of the body are performed. The oxygen contained in the red blood burns up the organic molecules with which it is in con-

tact, and produces heat, without which life is impossible. Under the influence of electricity is effected, during digestion, the selection of the nutritive molecules and their assimilation. The same action takes place in respiration and in all the other functions. These facts perfectly agree with the electric phenomena of combustion. The carbon takes the negative electricity and the surrounding air the positive, or rather the current is established between the carbon and the oxygen of the air. Now, the principal action of the red blood, by reason of the oxygen in it, is the producing a true combustion in our tissues.

An electric current can be produced by merely passing a current of water through a tube, across which a diaphragm of porous clay, powdered sulphur, &c., is placed, the intensity of the current being in direct proportion to the pressure. (Quincke).

So that it is to be presumed that we have sufficient proof to allow of the presence of electricity flowing from the blood to the nerves, muscles, and in fact all the tissues of the body, and that it is kept under control by the nervous system supervising its distribution, and by its presence or absence the various functions of the human frame are carried on.

When an electrical current is passed through

the limb of a live animal, the muscles contract, and pain is caused both on making and on breaking the current, no matter in which direction the current may pass ; but after a time the irritability of the nerves is diminished, and we find, when the current is direct, the muscles contract on closure of the circuit, and pain is felt when it is broken. When the current is sent in the inverse direction (*i. e.*, from the periphery to the centre), pain is felt on making the circuit, and contraction upon breaking it.

So long as the circuit is closed there is neither pain or contraction, owing to the particular state the passage of the current places the nerves and muscles.

The contractions are also stronger at the opening than at the breaking of the direct current, while the contrary is the case if the current is in the inverse direction. The action of the current upon a mixed nerve of an animal recently killed, or living, is remarkable. If a continuous current is caused to circulate in it, excitability is diminished or destroyed when the current is direct ; it is preserved and even increased when the current is inverse. If this same nerve has been traversed by a direct current, repose restores to it its excitability ; but if, on the contrary, we cause it to be tra-

versed by the inverse current, it loses by repose a portion of the excitability which the passage of this same inverse current had given it. These experiments require for their success moderate and feeble currents—intense currents always diminish the excitability of a nerve, and may even suppress it for a time. This will take place in a higher degree if the current is in the inverse direction, than in the opposite direction, which is that of the natural current that takes place in the nerve at the moment when, under the influence of the brain, this nerve determines the contraction of the muscle to which it abuts. (Matteucci).

If the nerves of a rheoscopic frog's limb be included in a galvanic circle, you cannot produce contractions of the muscles by acting on that part of the nerve that lies between the poles. Also if the spinal cord of an animal be included in the circle of a galvanic battery, the part embraced by the poles may be cut, pricked, torn, and even electrified, without causing any symptom of pain or convulsion. (Eckhard).

Upon the circulation, *feeble electric shocks* applied to the medulla oblongata and pneumogastric nerves, cause the heart to beat more quickly ; *strong shocks of electricity* cause the

heart to pause in diastole ; this applies also to the muscular coats of vessels and the alimentary canal. (Radcliff).

The experiment of Bernard (confirmed by Handfield Jones, Brown Sequard, and others), and has lately had attention paid to it by Benedict, of dividing the cervical sympathetic nerve ; all that side of the head inflames, an increased supply of blood is attracted to the part, the ear and eye become inflamed, and suppuration of the conjunctiva may ensue.

By the galvanization of the cervical sympathetic the following phenomena are produced. The pupils dilate ; eyelids partially open ; eye protrudes ; mucus decreases ; vessels contract and flow of blood decreases ; decrease of temperature and sensibility ; muscular galvanic current is weaker ; rigor mortis comes sooner and lasts less time ; and putrifaction comes sooner.

Many reasons have been given to account for these phenomena, Brown Sequard's being, that the sympathetic controls the muscular coats of the arteries, and when the nerve is divided on one side, the vessels which receive their nerves from the divided trunk are paralysed, and dilate, allowing a large supply of blood to pass to the part.

The observations on the sympathetic are so

numerous that we must thus glance at the importance of a correct knowledge of its physiology, as we are enabled to apply with confidence a direct or an inverse current, according as we may wish to stimulate a part or to counteract hyperæsthesia.

Benedict says that the galvanization of the sympathetic is one of the grandest victories of the present century, though its inventor (Remak) has only earned derision by it. (Electro-Therapeutic, Von Dr. M. Benedict, Vienna).

CHAPTER VI.

GENERAL PRINCIPLES OF ELECTRO THERAPEUTICS.

IN using electricity as a remedial agent, the first question that arises is, what form is to be employed, and what battery to be used ; and it is most important that a good and efficient one be selected, as upon it, and the knowledge and skill of the operator, based upon sound physiological reasonings, that its therapeutic effects and results will be effected.

For producing *aura* or *shock*, the friction glass plate or cylinder is employed. For producing the *primary current* or the *continuous*, or *so-called constant* current, for polarizing nerve trunks, for chemical action, and various other purposes, a Daniell's, or Smee's, or Grove's, or Pulvermacher's, battery is employed.

For cauterizing, or galvanic heat, Grenet's battery is the best ; or a dozen cells of Grove's, or six cells of Bunsen's may be used.

For a local alterative, as for healing old ulcers, a single pair of silver and copper may be employed, as recorded by Dr. Crupel, of St. Petersburg, and Mr. Spencer, of Wells. And for induction or Faradaic currents, which will probably fulfil the greater number of indications, we may use for the *Electro Magnetic* Ladd's Sulphate of Mercury Battery, or Legendre and Morin's, or Stohrer's, or any of these good coil batteries, with the requisites named; and for the *Magneto Electric* arrangement, any efficient battery, such as Ladd's, will answer.

PRELIMINARY INSTRUCTIONS.

In determining what form of electricity is to be used, great care must be observed, as real and grave results might ensue from the indiscriminate and injudicious *use* of so powerful an agent, which, like many other elements of nature, may be for good or for evil; therefore certain rules must be observed, such as the length of time the current is to be kept up, the strength of it and the direction of the current.

Great differences exist among patients as to their susceptibility to the effects of the electric current: these may be of two kinds, the first are those of *exalted sensibility* where the most feeble and gentle currents can be administered,

and the second are those of (as it were) a heroic temperament with neither anæsthesia or any paralytic lesion, who bear the current with marked indifference. We must study the temperament of our patients ; some will be particularly susceptible to currents produced by reflex action, others will barely notice it ; even in the same person the same current which has been borne in the morning cannot be endured in the evening ; the state of the atmosphere, the condition of the health of the patient, &c., will affect the sensation of the current; also in some cases a current that may do good to one of the same age, and sex, will be injurious to another, or may be quite useless.

It is quite possible to produce cerebral congestion, neuralgia, and even eclampsia (as Dr. Benedict of Vienna has seen), and other dangers from a too powerful dose, or too long an application ; but such can be always guarded against by caution and prudence in its use. We must make our first *seance* slowly, and cautiously, and for a short time only, and gradually feel our way in the case, when we may then proceed with more confidence, watching the results carefully as we go along.

A useful habit is that of making a record of each case, as in that of paralysis of a limb, noting *the muscles that are engaged*, whether any pain,

the temperature of the limb, the measurement at given points, the state of the muscles, and their response to various stimuli, as to pricking with the *Aesthesiometer*, and also under the influence of the Galvanic and Faradaic currents, and in the lower extremities to find out the angle the thigh can make on the body, how far he can use the limb, separate his feet, knees, &c.; all these points should be minutely recorded, as then we can determine from day to day the effects; sometimes even at one sitting a remarkable improvement may be noticed which would be thought nothing of but for our record; some will bear it well, others will not; some will feel drowsy or chilly, and others a degree of lassitude.

It is a prejudice to think that electricity can interfere with any other means of treatment, as the administration of medicine, &c. I have always found it to be a most powerful aid to other indicated remedies at our disposal; and it is also a mistake to suppose that extremely feeble persons, very young or very old people, should not receive the electric treatment: in my mind these are the very patients for whom it is most suitable; of course bearing in mind the endurance of the patient and the nature of the case, and adjusting the current accordingly. Dr. Remak says he has found it of the greatest value to aged and infirm persons, particularly

for prematurely old men and women. Also for "atrophic" children, those suffering from marasmus, rickets, and scrofula.

In recording cases, great care also should be observed in particularizing the nature of the sensations of the patient, the physiological effects produced, the form of electricity used—whether *Galvanization* or *Faradaization*—the quality, strength, time, manner of using the electrodes, *kind of electrodes*, the *direction of the current*, interruption, alternation, &c. It is greatly to be regretted that much that has been written of late years in medical journals, &c., is very deficient in these particulars. The patient may be said to be galvanized, when probably these magneto-electric machines are used, the patient perhaps holding the *two absurd tin handles*, one in each hand ; he has then been electrified, and the patient is said to have tried galvanism without benefit ; and thus discredit is thrown upon a remedy which, if properly used, would have been successful.

This ought not to be so ; and the author is of opinion, if more were known practically of the subject by medical men, it would be a much more popular remedy. In the great majority of instances it is left till all other means have been used, and then recommended as a *der-*

nier resort, when, if tried at the commencement, it would have been at once successful.

We may then consider electricity, indicated as a remedy, when we wish to *stimulate* by a given form muscles which may be defective or wanting in muscular power, as in paralysis, to promote digestion, or any of the secretions, to cause peristaltic action, absorption, and circulation ; to rouse the system, as in asphyxia, syncope, extreme exhaustion, poisonous effects of narcotics, suspended animation, &c.

To correct deranged sensations, to relieve pain, as in neuralgia and rheumatism, to renovate exhausted nervous and vital forces, to act revulsively on the nerve centres in various internal diseases, even including some chronic inflammations, congestions, and organic plethora, and rheumatisms ; and, by its chemical action, to coagulate blood, as in aneurisms and varicose veins ; to alter and remove various tumours and glandular conditions ; and as a cauterizer for stopping hemorrhage, cauterizing nerves and sanguineous growths, &c.

The method for using static, or frictional electricity, has been described at page 5. It is seldom used, but may with advantage be tried in cases where it is necessary to arouse, and increase, the vital powers when sluggish. It

has been greatly esteemed by some physicians in curing chorea, hysteria, epilepsy, paralysis, poor sight, nervous deafness, rheumatism, in *amenorrhœa*, by passing shocks from the pelvis to the sacrum, and in other cases ; but for all practical purposes, we have in galvanization and Faradaization a much easier and much more certain means of applying electricity in all such cases, as determined by a commission of the School of Medicine, Paris. See Becquerel, vol. i.

GALVANIZATION.

To Drs. Duchenne (de Boulogne) and Remak, of Prussia, we are indebted for the remarkable discovery (simultaneously effected), *that there are certain spots along the surface of the body and limbs, that give very peculiar response to the electrode, in producing more ample muscle contractions without pain.*

In a recent work, by Dr. Maurice Meyer, on "The Uses of Electricity in the Practice of Medicine," published in Germany, we find the following description of his method :—" To produce electric excitement of the 'motor nerves' or muscles, we must lay wet excitors with active induction currents on those points of the skin which lie as much as possible imme-

diately over the said muscles. We find that the surface muscles of the trunk, as well as those of the extremities, by operating in the manner thus prescribed, may easily be made to *contract*; while many of the deeper lying muscles may be reached in the region of their source or of their concourse—for there are such places—where they are peculiarly accessible to the direct in-working of the electric current. Where this is not the case, we must apply a more intense current, or have recourse to *indirect Faradaization*, which, though probably less efficacious, either as effect or as a remedy, is however here to be preferred." The fact of muscle border joints has here, no doubt, been observed. No allusion is made as to the action being made through the nerves, but direct excitement of the muscles is inferred.

By applying wet electrodes to the surface of muscles, with moderate induction currents, we will sometimes produce a contraction of the muscle, or at least some of the fibres of it, especially if the skin is thin, as in the pectoralis major. This is what Dr. Duchenne refers to, to prove the effect of the Faradaic current through the fibres of the muscle, *independent of the nerves*.

According to Dr. Duchenne, he can localize the current in a single muscle, or nerve only,

but to my mind, such a procedure is impossible, as, by applying the current, we must more or less excite the nerves of the skin and the muscles, and also of the neighbouring contractile tissues, not to mention central reflex action, which is a result claimed by some of the most eminent electro-physiologists and therapeutists.

The influence of the current will be sure to deviate from the line formed between the two electrodes (as over the course of a nerve), sometimes on one side, sometimes on the other, especially where the tissues are moist.

Several of these, *by workings* of the current, cannot be avoided, nor are they of any great importance ; but there is one effect of the primary current (such as is produced from a Daniell's or a Pulvermacher's battery) that is to be avoided, *i.e.*, when the current is applied to the region of the head or face (if active), flashes of light, dizziness, metallic taste, noises in the ears, and a tendency to tilt the head to one side, is produced ; and if applied near the eye, severe inflammation of the retina may be caused. These effects are, of course, to be avoided, but they will always be an evidence of the power of the current.

Several effects are also felt by many after an application of any of the forms of electricity, and no certain length of time seems to deter-

mine their character. These are, in some, a sensation of the current working in the part, a sense of twitching ; in others, a prickling sensation. There may be a glow, or additional heat, or perspiration in the limb, and the patient may have a metallic taste in his mouth. These symptoms are rather to be looked on as favourable, and as showing that the patient is susceptible to the treatment.

The remarks of Dr. Duchenne, in his work on "Localized Electricity," respecting the inutility, and even danger of employing the primary galvanic current, have prevented its use of late years, so that very little experience within the last fifteen years or so has been obtained, except by a few, whose evidence, however, is so good as not to be either treated lightly, or passed over without due examination.

The first of these to be mentioned is Dr. Robert Remak, of Prussia.

According to Dr. Duchenne, "a weak and continuous current of galvanism, when '*localized*' on the skin, will cause pain, erythema, and even blisters ; while a stronger current will produce, when carried into the substance of a muscle, only feeble, irregular, and uncertain contractions." This, he says, is the result of an experiment made on himself with a battery of one hundred and twenty Bunsen's

cells. This constant current also produces the evidences of heat in the profundities of the organism, all of which phenomena are wanting if we use only fifteen to twenty elements" (?) In the fourth chapter he gives further proof, showing the workings of the constant current on the *retina*. It there appears that some new kind of galvanic apparatus was brought to him by the inventor, while a patient was present, suffering from paralysis of the face. The new machine was used, and the patient nearly lost his sight. In a second case, he also used a new galvanic arrangement (his own invention), known as the "*Pile à Rubens*," just as he was treating a patient for double-sightedness. When the Doctor applied the current of this to the eyes of the patient, the latter jumped up, shook his head, and then exclaimed, "You have only one head ! I no longer see double." This, in truth, is all we can learn from Duchenne on the therapeutic or physiological value of galvanism by the so-called constant or primary current.

It is true he mentions, that the galvanic current gives less pain than the induction current, and as causing blisters and quick erythema. Speaking of his apparatus, which he uses for treating diseases of the retina,—*pile à rubans, made of copper and zinc ribbons, moistened*

with the vinegar of wine, and hence extremely irregular in tension,—he says, “it (galvanism) is so uncertain in action, and so unmanageable, that it is quite unsuitable for other physiological or therapeutical purposes.” Such is his experience from his own showing.

Dr. Remak, speaking of the action of the primary galvanic current, says : “ I found from the multitude of my electric treatments, and especially from my experience with such patients as had been previously treated by some other surgeons with the induction currents of magneto - electricity, or electro-magnetism, ‘ powerfully localized ’ on the muscles, according to Dr. Duchenne’s method, and particularly *in those cases of paralysis that arose from a central cause*, that although there were readily produced plenty of tetanic or clonic convulsive movements in the affected muscles, by means of the induced (secondary) current, still they did not appear to restore the *voluntary* motive power ; but, on the contrary, they sometimes evidently lessened this where it already had existed in some little degree, and that *this capability for voluntary action* appeared to be thus actually diminished by the strong induction currents, exactly in proportion as the given case of paralysis was depending at the time on a central source.” (?) Afterwards he treated a

great number of patients, by the two electric currents, and the total results confirmed him in favour of the use of the primary current of galvanism, especially for those cases of paralysis, contractions, and fixed joints that *depend upon an existing central lesion.* (?) Dr. Garratt says this, "the greatest proposition of Remak, he cannot fully indorse." Still, there is involved a great physiological principle, that ought to be watched more and more, as one of the first laws of disease and cure, viz., "reflex action."

M. Becquerel, Dubois-Reymond, and Remak are of opinion that the properly managed constant current of galvanism can produce good and effective service in spasmodic diseases, not because of the paralysing effects, nor from that tendency, but, says the latter, "because in certain cases it *restores to the central organs their power of dominion over the action of the nerves and muscles,* the want of which produces or allows clonic spasms and cramps ; in other cases because it removes, by electrolytic in-workings, the peripheric or central irritation, where such is possible, through which many cases of spasmodic contractions are produced and maintained, often until the organism itself is destroyed."

Dr. Remak also says, that, on account of the *great variations in the excitement of the motory*

and sensitive nerves of patients paralysed from central or even local peripheral causes, it is absolutely necessary for those who wish to apply the primary current of galvanism as a remedy, to be first well provided with every facility necessary *to give a perfect command over the current* as to strength, the varying of its intensity, interruptions, reversing its direction, and as to electrodes of different sizes and material, as also the simultaneous and similar command of an ample induction or Faradaic current. He needs these, he says, at least to work up the sunken excitability of the nerves, so as to produce powerful contractions, and at the same time not torment the sensitive nerves, nor yet to fatigue or exhaust the muscles. He says he has found the key-board, or manipulator, of great use in regulating the current, when the constant (Voltaic) current is used. Remak also urges the uselessness of the local excitement of the muscles and the nerves of the muscular fibre, where the excitability of the large nerve trunks is really *diminished*, or quite gone, as in lead palsies. In some cases of "progressive muscular atrophy," he found the excitability of the nerve trunks less than the ultimate twigs that were in the muscles, although then much wasted by the progress of the palsy. He, therefore, recommends that in every case the

exact amount of excitability of the nerve trunks should be ascertained, and defined, and then to proceed to the restoration, now in this, and then in the central direction, as may be indicated, or we may find to give the best results.

The degree and extent of the true electro-muscular excitement seem to be *in proportion to the sum of the motory nerve branches or fibrils that are embraced by the current*,—*i. e.*, that lie under, near to, and between the electrodes. Dr. Remak interprets the weak, or partial surface workings of the electric current, from being applied along the course of the muscle fibres, as only the consequence of an excitement of the few superficial nerve twigs, and which he calls “*extra-muscular action*;” while the cont action of the muscles, through their la ge nerve trunks, he terms “*intra muscular action*.” Dr. Duchenne terms the former the *direct*, or *immediate*, and the latter, *indirect*, or *mediate* Faradaization—for Duchenne believes in the Hallerian irritability ; Remak that nerves are essential to muscular contraction.

It has been shewn that the arteries and veins of living animals, when subjected to a strong induction current for some ten minutes, do then actually dilate.

Drs. Duchenne and Remak have both of

them Faradized the diaphragm of man, the former operating through the *phrenic* nerve. The latter says : "The diaphragm seems to be a participator in the acts of respiration even more than any other of the thoracic muscles, and is susceptible to immediate electric excitement. I have produced by Faradaic currents on some healthy young men instantaneous, violent, and painless contractions of the diaphragm, which were indicated by the vaulting of the abdominal parietes, on placing one electrode in the pit of the stomach, while the other was on the most prominent curvature of the seventh and eighth ribs of the right side. It was interesting to observe the phenomenon while the currents were retained there, for, immediately after the current was applied, the tonic contraction (which was inferred from the arching of the abdomen) ceased, even while the current was still running. This was then gradually succeeded by a to-and-fro flapping of the parietes of the abdomen, and at the same time these persons experienced a feeling of hiccough. This clearly proved that the diaphragm was assuming its natural rythmatic contractions, even in the midst of the action of the electric currents, and while struggling with them. When the electrodes were removed the diaphragm took on its normal functions.

Therefore, to electrify the muscles by the galvanic or Faradaic currents, we must be familiar with the bifurcation of the nerves (or "border points") that mark the entrance of the large nerves into the muscles. This can only be obtained by practice on healthy persons. The motor nerves nearly always enter the muscles on its sides, and it is best found (according to the method of Duchenne) by moving the wet conductors (ball electrodes covered with wash leather) along the borders of the muscles, until the spot is found and known by a good contraction. The operator will soon find out by these contractions the place where the nerve enters, as, for instance, the muscle *biceps*, or the *deltoid*, or *pectoralis major*, &c. He should apply one of the electrodes near where the nerve enters, while the other should be applied lengthwise and somewhat obliquely in the direction of the long fibres of the muscle. These points are to be sought for when treating a set of paralyzed muscles, so as to cause prompt and certain contractions ; the same effects are produced by any of the currents we may use. By so doing, we use a less current, save time, cause less pain, and in case of central lesion, as in cases of apoplectic paralysis, we avoid in a great degree the hazardous excitement of sensitive

nerves, which will be more generally acknowledged to produce a greater or less degree of reflex action.

Sir C. Bell has taught us that the muscles do not distinguish between heat and cold, and every surgeon knows how little pain is felt when they are cut through. Duchenne observes that, in wounds of the muscles, the electrification of them produces only a dull kind of sensation, but no actual pain ; but still it may be possible to cause pain in muscles by means of electric excitement.

A current of galvanism or Faradaism through the motor nerves will often cause a complete contraction of the muscles without the least sensation of pain ; but still we cannot altogether avoid the sentient nerves. Dr. Duchenne advises the bringing together of the two electrodes before applying them.

As a rule, the excitability of nerve trunks, shown by contraction or pain, seems greater the nearer the excited portion of the nerve lies to the brain—for example, we will cause a more powerful contraction of the hand, the nearer to the brain the median nerve is excited.

It must be noticed that any absence of contraction, twitching, or sensation may not be attributable to any want of action in the current ; it is best in such a case to include a

galvanometer in the circuit, so as to determine the exact degree of strength of the current passing.

If any of the currents (especially the primary) cause a feeling of coldness over the part where the electrodes are applied, or if goose flesh is caused (provided it is not from any chill, as from cold water in the sponges), we may infer that the nerves are sick and weak, or there may be actual disease at their roots, or in the nerve centres. Then this is not a case fit for galvanization, and we must resort to Faradaisation. This will often be a good means of diagnosis, as the Faradaic current will be of great service in causing the nerves to resume their healthy action, so that we may employ the galvanic current with advantage, or both currents alternately with the best results. In some cases the sensation of coldness soon passes off, and in a few minutes a glow of heat is experienced, in which case we must then use the primary, and it may aid the secondary current in causing a cure.

To excite nerve action, wavy currents are produced, by means of small metallic electrodes, covered with wash leather, flannel, or fine sponge, and drawn over the course of a nerve, once in every five or ten seconds, and

to cause frequent changes in the strength of the current.

To calm nerve action, steady, down-toning currents are required. We must have large conductors covered with moist sponges, which must be slowly and gently applied over a nerve course, for from one to five minutes, and then removed, and applied again after the same interval. Great care and nicety are required ; the strength of the current also should be gentle and moderate, so as not to pain the patient.

A difference must be observed between the *entrance* and *leaving* muscle contractions and the *closing* and *opening* contractions. The first occurs when the current begins to circulate through the parts, while the latter occurs when the current is broken, interrupted, or opened (which terms mean the same thing). The term, "*entrance contraction*," refers to the putting on the conductor while the current is still running ; and the term, "*leaving contraction*," refers to the removal of the conductor while the current is still running. While the term, "*closing contraction*," refers to the *closing*, or making the circuit ; and the "*opening contraction*," refers to the opening or breaking the circuit. The latter division is stronger than the former, so that when we wish

to increase nerve action, or to cause increased excitability, the quick making and breaking of the current is the best ; while to calm nerve action, or to allay excitability, the gentle putting on of the conductors, with an even-running current, with a more lengthy application, is desirable.

From a long experience in Electro Therapeutics, from practice, and from the experience of many eminent writers, including Remak, Garratt, Benedikt, &c., we must conclude that the constant, or primary (voltaic) current will place the nerves of a given case in a condition more favourable for the exertion of the voluntary influence of the will, or to re-establish its lost capability (which is to effect a cure), better than any other remedy we know of. The same can, no doubt, be done in *certain cases*, with *well managed* induction currents, but with much more difficulty, and a much longer application than the galvanic (continuous current). Much has been said and written relative to the paralysing effects of this same continuous current, and numerous experiments and observations produced to prevent its application. Of course, if a strong continuous current be made to pass through a nerve, muscle, or limb, it might, if sufficiently powerful, cause atrophy of the nerve, or paralysis of

the muscles ; but the same might be said of any other remedy. It is well known that if manure, as guano, is applied too freely over a field or garden, it kills ; but it does not follow that we are to give up the use of manure as a fertilizer, because we do not know how to employ it. So it is with this most powerful of all remedies, which, if thoroughly understood, as to its methods of application, cannot fail to be a most powerful agent in the hands of the medical practitioner. The writer does not mean to decry the beneficial uses of the induction or Faradaic currents, which, it will have been perceived, he has recommended in certain cases, either by itself, or in conjunction with the galvanic current.

The induction current will of itself prove in the great majority of instances of great value, while in other cases the galvanic (continuous) current will be the best, or will materially aid in the successful treatment.

It is the author's purpose to lay down such rules and directions as will prove useful in carrying out such treatment ; and as the purport of this work is the practice of *Electro Therapeutics*, the entering into vague speculations on physiological or other questions will not be attempted. Any person interested in such will find ample information in the stand-

ard works of Duchenne, Remak, Benedikt, Meyer, &c., while the practical experience of such men, which is here given, will guide the physician in his choice.

TO ELECTRIFY THE NERVES.

The following directions will apply with equal importance for any of the currents that may be employed, whether frictional (or Franklinic electricity), galvanic (or Voltaic, or the so-called continuous or primary electricity), and the Faradaic (or induction electricity).

Too much importance cannot be given to the direction of a current, whether in any of the above forms, as also the duration, interruption, reversion, &c., of the current, as on these points will depend the success or failure in practice.

By applying the two electrodes of a battery over the course of a nerve the *positive* being the *furthest* removed from the head, and the *negative* an inch or more divided from it, there will be an *up-running current*—*e. g.* from the positive to the negative. The effect will be the same if the positive electrode be placed on a muscle, so that it be below the seat of the negative; when the current is so directed it stimulates the nerve to its centre, and in this manner the whole nervous symptom. Many

cases of nervous and chronic affections, cerebral congestions, &c., will not admit of this procedure, so that great care must, in all such cases, be taken.

But if the poles are changed, so that the positive is where the negative electrode was, there is a *down-running current*; *e. g.* still from positive to negative, from the centre outwards to the muscles. If this current be moderate and steady, and allowed to run for from five to ten minutes it has a most calming, soothing, sedative effect on irritable and painful nerves and muscles.

But if the positions of the conductors (electrodes) be suddenly reversed and sudden interruptions made (as can be more effectually done in the case of the galvanic streams by the key board or current changer, and in the induced current by drawing out the bundle of wires from the coil) a decided stimulation of the nerves and muscles, even to their centres are produced, so that we may regulate the stimulating effect in an up or down-running direction as we wish. It is on account of this stimulant effect on the nervous centres that faradization of the brain in diseases caused by cerebral mischief is injurious. The constant current is always to be used in a mild manner (never more than ten or twelve cells of a Daniell's

battery), and not longer than half a minute, as advised by Benedikt, who has seen dangerous symptoms from using more and longer continued currents. If giddiness or congestion should arise, we must diminish the duration and intensity. Fits and eclampsia indeed might be produced by the injudicious use of a current when applied near the brain.

If a current be run transversely across a nerve or muscle it will have little or no effect.

It is important to remember these few fundamental facts.

Notwithstanding which, the great learning and experience of Dr. Duchenne (de Bologne) led him, it seems, to the following somewhat different conclusions, which the author has condensed, but does not necessarily endorse (see Duchenne) :—

1. “In man whatever may be the direction of the currents, or the degree of vitality of the nerves they traverse, the same results are always produced when the conductors are applied to any portion over the course of the nerves, namely, muscular contractions and sensations.

2. “When a moderate or pretty strong current is prolonged for a considerable time, running along a healthy nerve, whether the current be continuous or interrupted, *i.e.* primary or secondary, if there are interruptions it weakens

neither the sensations, the contractions, nor the voluntary movements, nor produces any reflex phenomena above the point excited.

3. "Where an electric current is long protracted in its running through a nerve that is already considerably debilitated, it very notably lessen its excitability, but without influencing the voluntary motions in the depending muscles.

4. "Various changes in the current direction produce no appreciable influence over the sensibility or capability of voluntary muscular contractility in man.

5. Electrization of the terminal nerves in a limb produces sensations only in the points thus excited.

6. "An electric current which is caused to pass from the nervous terminal towards, or to the nervous centres acts principally on the sensibility of the limb, and produces above the point thus excited contractions which are irregular, and not in proportion to the degree of sensation.

Duchenne then applies his treatment "*localized faradization*," regardless of the relative positions of the electrodes and the direction of the current. He entirely ignores the laws of Dubois-Reymond, with one exception, viz., "should there be cerebral lesion existing at the time, the inverse current might do serious mischief."

He denies that headache, giddiness, neuralgia, &c., may be caused by a strong up-running current, even though there may be no cerebral mischief. He also denies that the steady down running current produces in certain cases a calming and permanently sedative and tonic effect, and that the sudden and repeatedly reversed current over a nerve tract is capable of restoring its tone, muscle contractibility, hyperæsthesia, and irritability.

Dr. Duchenne's grand electric remedy is simply *localized faradization*, and is effected by some kind of Faradaic apparatus, Electro-Magnetic or Magneto-Electric.

It is not to be supposed that the author disapproves of localized faradization; on the contrary, in suitable cases, it is the best and only treatment to practise; but he cannot see how that all cases suitable for electrization are to be treated by this one way of procedure.

For particulars of this method see Faradization.

Galvanization of the sympathetic nerve according to Benedikt is the most effectual plan for the treatment of cases that are of intra-cranial origin. He gives some surprising cures of what might be termed incurable tic douloureux. Great caution must be observed as

dangerous consequences might ensue by a careless application to the sympathetic. The seance should not occupy more than half a minute, and never more than ten or twelve cells of a Daniell's battery—the occasion of giddiness should cause us instantly to desist. Sometimes the application to the sympathetic must be combined with one to the head also, the sittings should be every day, or, if the patient bears it but badly, twice or three times a week. Sometimes he has found the Faradaic treatment of great service combined with galvanization.

The galvanization of the sympathetic is performed by applying the conductors in the direction of the carotids, the copper pole above the sternum, and the zinc below the angle of the jaw; there will be a strong pulsation of the carotids produced. Both sympathetics should be galvanized, and the one that is most sensitive is the one to be operated on.

Dr. Benedict also directs that the stream should be applied to the vertebral branches of the sympathetic.

The galvanization of the sympathetic, according to this author, is one of the grandest victories of the present century, though the inventor, Remak, has only earned derision from its discovery. The "sympatheticus frage" is a most

interesting question, and it is to be hoped will occupy more of the professional mind than heretofore.

In neuralgic affections, with *vertigo*, neurotinitis, symptomatica, &c., the galvanization in the direction of the carotids has such splendid effects (says Benedikt) that any one must be mad to deny the facts.

Too violent galvanization of the sympathetic will produce congestion and violent irritation of the brain. Grand effects are produced if rheaphores (conductors) are applied to the sympathetic in muscular atrophy, hypertrophy, arthrites, and lead poisoning.

Benedikt lays down as a rule that electricity to be of use must be applied to the seat of the disease, and points out the importance of careful previous diagnosis, which, if not followed out, our labour will be in vain. He cautions against the use of faradization where there is cerebral mischief, and says it is of no use in these cases. The constant current from a small number of cells (ten or twelve of a Daniell's) is to be applied to the long or short axis of the cranium, lengthwise: zinc to forehead (right or left); copper to nape of neck. The zinc is applied first, and the copper is taken off first, to prevent *vertigo*.

You must galvanize through the length of

the brain if disease is in the hemisphere, central ganglia, and partly in the axis of the brain. The current not to last more than half a minute at any time, and great caution must be observed.

It is a rule that cerebral and cerebellar irritation, contra-indicates the peripheral treatment, while paralysis and anaesthesia, after a certain stage of progress has been reached, demand it. The peripheral treatment, *e. g.* positive (copper) pole on spine; negative (zinc) on the nerve which we may wish to act on; or positive pole on the nerve, and the negative on the muscle it supplies, or finally local faradization. The peripheral treatment is only to be used when irritation has disappeared, but where there is contraction an exception may be made and the peripheral treatment used from the beginning.

The intracranial nature of the disease in general may be found by the nature and seat of symptoms, without having any point of localization, as in paralysis of the muscles of the eyes, and isolated neuralgic affections.

Spinal symptoms are to be treated in four methods. 1. Galvanization along the vertebra (up or down current), the principal being to send the current to that part of the cord which we suppose to be specially affected. If any vertebra be tender on pressure or sensible to

the current it should be made to come out of this sensitive place, by putting the zinc pole on this part, the current to be regulated according to the sensitiveness of the patient. Such an application may be continued for five or six minutes unless the patient feels worse.

Neuralgias and spasms of spinal origin are to be treated in this way. The number of cells of the Daniell's battery will vary, but if the patient can bear it we may use up to forty of them.

When the seat of the affection is principally confined to the upper part of spine, the up-running stream is to be used, and the down stream has to be used in the opposite case. It is to be applied locally if on a spot, or all along the spine if the symptoms are general.

2. Galvanization of the cord and nerve roots is to be applied in cases of neuralgia apparently originating in the nerve roots (a large class according to Benedikt). The positive pole is kept fixed on the vertebra opposite the highest nerve origin that can be concerned, and the zinc pole is to be stroked downwards (labile currents) about forty times. This is a most powerful mode of treatment, and according to our author seldom fails to cure idiopathic neuralgias in a short time.

3. Galvanization from cord to nerve, from

cord to muscles, and from cord to painful, or anæsthetic skin, may (as mentioned in cerebral cases) be needed in the progress of treatment of spinal paralysis and anæsthesia.

4. And, finally, local treatment, by galvanizing nerve and muscle, or by Faradization of skin and muscle.

Dr. Benedikt also lays down rules as to the distinction between the constant and Faradaic currents. Galvanism only must be used in all cases where we wish to affect the brain, the cord, or the sympathetic. In central paralysis, where the continuous current has caused a restoration of the voluntary power, local Faradization may often be applied to restore the *nutrition* and the *electric sensitiveness* of the muscles, which in many cases remain defective. (The primary current should be used).

Centrally produced anæsthesia, which will not get well with galvanization ; Faradization with dry conductors and secondary current will often complete the cure.

In central neuralgic affections and spasms, Faradization does great harm.

The alternate use of the Faradaic and the galvanic current is often of great use in hysterical and facial paralysis. In peripheral hyperæsthesia, such as the rheumatic, and in some neuralgias the Faradaic current may do good,

but only if there is no neuritis, or hyperæmia, when it will do much harm. (The secondary current is to be used).

We are never to use a painful or intense current, with the single exception of hysterical paralysis and hyperæsthesia, and then only with chloroform.

If the patient is not sensible to a current, we can use a stronger one, always excepting the brain and sympathetic, the object in all cases being to procure the equilibrium of the nerves.

For resorption, galvanism is to be preferred; and the author, in illustration of his very valuable work, gives some remarkable cases of the power of electricity to remove solid and fluid exudations from joints, and to effect certain trophic changes.

It has been thought well to bring the experience of this, the most modern and one of the best-informed authors on this subject, prominently forward, and his views have been, in most particulars, fairly translated. Those who wish for more information, can refer to the work itself. (*Electro-Therapie, Von Dr. M. Benedikt, Vienna, 1868.*)

Electrization of Muscles.—To perform this we must either act *directly* or indirectly; in the former case, by applying the conductors *directly* over the belly of the muscle (by reflex

action), and in the latter, by acting on its motor nerve. We may do this in two ways—either by applying both conductors over the course of the nerve, the positive being nearest the head, or through nerve and muscle together, the positive being over the nerve, and the negative over the muscle.

The skin should be moist, and moist sponge electrodes should be used. When we wish to reach a deep muscle or nerve, a metallic ball electrode, covered with wash-leather, well moistened, is to be used. The following rules should be adhered to :—1st. No more power should be used with a battery, whether galvanic or Faradaic, than that which is sufficient to produce a full and easy contraction. 2nd. The electrodes should be large, moist sponge, as in Fig. 12, from one to two inches diameter, (except for the deeper muscles, when a small ball conductor is used). The sponges should be kept clean, and well moistened in plain water, or water acidulated, or salt and water ; and, 3rdly. We should guide the positive electrode over the most superficial nerve that supplies the muscle, or muscles, while the negative is made to operate slowly over the course of the muscle. Sometimes we must alternate the position of the conductors. The electrodes *should never be allowed to rest long over or*

upon exposed bony spots, or tendons, as it gives much pain, and is of no use (unless purposely treating diseased joints). Thus by this method, which is far less painful than the direct method, we can with far less pain act on, and thoroughly arouse, deep-seated muscles and nerves, without any disagreeable sensation; and in such cases as cold, chronic rheumatism, paralysis, and debility of nerves and muscles, will do much good, without causing any pain, but, on the contrary, most patients regret when the *seance* is over.

There are, doubtless, some cases of diseased nerves, apart from hyperæsthesia and neuralgia, where the muscles, though they may retain some voluntary power, show no procurable muscular contractility, while the sensibility is so great that no kind of current whatever can be borne. Such cases, of course, will require the attention of the ordinary means at our disposal, apart from electricity.

To electrify the skin, Faradization is usually employed, and for this purpose the skin should be thoroughly dried and powdered, and dry metallic conductors employed, or the brush conductor (see Fig. 14), and the full battery current used, except it be too painful; or it may also be performed by drawing sparks from the negative pole of a frictional machine.

It is a most powerful revulsive, and local alternative, and is used to allay local morbid hyperæsthesia, or pain, and for producing revulsive and reflex effects. The conductors should be applied near together, or else one should be over a nerve trunk, while the other is moved over the affected part.

ELECTRIZATION OF THE ORGANS OF SENSE.

All the forms of electricity will excite the nerves of the organs of sense. The effect, however, is quite different. Thus, the effect of galvanization is quite different from Faradization. In stimulating the retina, the latter form will have little or no effect, while galvanization will produce intense excitement and inflammation, as I have seen frequently with a Pulvermacher's battery, when applied to the face for the treatment of facial neuralgia.

The magneto-electric current will also have more effect on the retina and the other organs of sense than the volta-electric, which is owing to the greater amount of tension in the latter, and also that the variations of the current are not so sudden and frequent as that induced by voltaic electricity. The current also induced in the second wire of any induction apparatus, which is long and fine (Duchenne's current of

the second order), will answer the purpose better than that of the primary (induced) current. As regards the direction of the current, the positive will act more on the retina and the tongue than the negative, but when applied to the ear, the effect is stronger when the negative electrode is applied.

The Organ of Sight.—For neuralgic, rheumatic, or painful affections of, or about, the eye, the Faradaic current must be used, or is to be preferred ; but where stimulation of the optic nerve is required, then we may use frictional electricity. Negative sparks may be drawn from the eyeball through the closed eyelid ; or galvanization may be used, by applying the *positive* sponge electrode over the affected eye, and the negative applied to the nape of the neck ; or both conductors may be applied to each closed eye, for a few seconds only at a time. Flashes of light, or metallic taste, will be sufficient evidence that the current is strong enough.

The Organ of Smell.—Any insulated conductor, with a very small metallic or sponge tip, may be used to stimulate the sniderian membrane. For loss of smell, or other cases, the Faradaic currents are best, unless the sensibility is greatly exalted, then it will be well to use *mild* doses of the galvanic current, such as

is produced from one chain of a Pulvermacher's battery : the positive conductor introduced into the nose, the negative under the chin, or at the pit of the stomach. We require to be rapid and smart in this procedure, as it causes much pain.

The Organ of Hearing is electrified, according to Duchenne's plan, by filling the ear with water, and then introducing into it the end of the conductor of an induced current, while the other is applied to the nape of the neck, or behind the ear itself. If the continuous current be used, the negative electrode must be introduced. Or it may be performed by simply moistening the meatus and tympanum with warm water, and then introducing the conductor. The ear electrode can be simply made by an insulated wire, tipped with a very small, fine bit of sponge. The evidence of noise, metallic taste, or any sensation of the tongue, is quite sufficient that the current is strong enough. Thus used, it is quite safe, and is invaluable in certain cases of deafness, and other affections of this organ.

The Organ of Taste.—An insulated metal conductor, or sponge tip, may be passed over the tongue and palate, while the other electrode is placed under the chin, on the nape of the neck, or pit of the stomach. The effect of

galvanization is greater than that of Faradization in these cases.

Electrization of the Throat.—For a rheumatic, neuralgic, or debilitated condition of the pharynx or larynx, or for paralysis of the vocal cords, when not caused by, or complicated with, organic disease, or lesion, nor symptomatic of other diseases, electricity is the most valuable of all known remedies. A small curved insulated electrode, with a metallic, or sponge tip, is to be passed along the pharynx, below the posterior part of the larynx, while the other, the negative electrode (a large sponge-shaped one), is to be applied outside the throat, near the crico-thyroid muscle. The current is then to be allowed to pass, and the inner electrode to be gently moved up and down for a quarter to half a minute, as the patient can bear it. Some will do so well, others cannot tolerate even the weakest current we can use. This is one of the most valuable remedies for affections of the muscles and nerves of the throat. For weak or rough voice, or total loss of voice (aphonia), none can equal it ; and much as men may deny the beneficial uses of electricity, in certain diseases, none will venture to contradict these assertions. The voice is sometimes restored, in some cases, by simply *Faradizing* the outside part of the throat ; and

I have known it to be of great service to public speakers, as clergymen and singers.

Dr. M. Mackenzie has paid great attention to this subject, and the following are his directions for the treatment of aphonia. He says : While other remedies (inhalations and local applications) often fail, "there is one remedy which is always successful. This is the direct application of electricity to the vocal cords. Electricity, applied externally, seldom restores the voice, when it has been lost for any length of time." "The internal current is, on the other hand, almost invariably successful. In other words, when the voice has been restored by the introduction of a pole into the larynx, the effect can often be kept up by the occasional application of the current externally."

"In using the direct current, one pole is introduced within the glottis, and the other pole applied externally," by means of the necklet (see Fig. 17), which should be worn rather low, so that it covers the sides of the cricoid cartilage, and the space between it and the thyroid. Numerous cases have been published, to show the value of this treatment. The source of the electricity, he says, is a matter of no importance. He finds equally good effects follow with any of the forms of the current." "When the affection is due to

chronic toxæmia, the direct application of electricity to the muscles of the affected cord (vocals), often does good ; but in those cases, the nature of which is involved in obscurity, and which appear to me to be due to an affection of the muscles themselves, no treatment seems of any avail. Perhaps it would be more correct to say that, in recent cases, the voice can generally be restored without much difficulty ; but where the aphonia has been of many years' standing, before a laryngoscopic examination has been made, treatment is of little use. For here it is not, as in bilateral paralysis, where the reflex action of the muscles is not interfered with. On the contrary, in these cases, there does not appear to be the slightest movement, either in simple expiration, or in the various expiratory acts. I have latterly, in some cases, employed my laryngeal electrode in a modified form. I call the original instrument (Fig. 17) No. 1. Then I have an instrument, No. 2 (Fig. 18), which contains two electrodes together, carefully insulated, and separated at their extremity by about one-eighth of an inch. This is very useful for the electrization of the thyro-arytenoid, arytenoideus proprius, or posterior crico-arytenoid muscle. In the laryngeal electrode (Fig. 18 B), *the extremity of the two poles are separated*

about five-eighths of an inch, or rather more. This instrument is introduced, so that one pole is in the larynx, the other in the hyoid fossa. In this way the current passes right through the lateral adductor of the vocal cord, to which it is applied. The instrument is constructed so that when introduced, the outer or hyoid pole, is slightly posterior to the inner, or laryngeal pole."

ELECTRIZATION OF THE INTESTINES, UTERUS, AND THE BLADDER.

It is well known to most medical electricians, that patients who are under treatment and require the electrical application to the spine or near the stomach, intestines, &c., are particularly subject to a relaxed condition of the bowels. In one case of paralysis (under my care) in which there were spinal symptoms, each time the lumber vertebra was electrified the patient had an unavoidable desire to go to stool; and in this case the bowels were unusually constipated. No doubt this may be brought about by the reflex action of the sentient nerves. The movement of the stomach when galvanized is always downwards from the cardia to the pylorus, and the bowels are also stimulated to contraction in the downward direction, when an electric current is passed.

For the various conditions of the bowels known as constipation, atony, illeus, &c., wherever we may suspect any want of tone, where there is constipation due to the secretion of flatus, causing an over distention of the parietes; we have the evidence of Dr. Treusseau of Paris, Dr. Cuming, and many others, of its great value, which, from my own experience I can corroborate, as I have cured many cases of obstinate constipation. There are numbers who complain of these symptoms, who, though they may live regularly, have regular stool habits, and do not pass a very sedentary life, still suffer from a general weakness and torpid state of the bowels, sometimes referred to the liver. In these cases the proper application of electro magnetism, and sometimes galvanism, will not fail to cure. Intestinal atony arising from want of peristaltic action of the bowels, shown by constipation, and tympanitic distension of the abdomen, *when applied in time*, may go a great way in curing the patient, even though the cause may be unusually unfavourable. I am sure I have seen cases where the timely application of the agent might have gone a great way in relieving the patient, and perhaps have saved life.

The method of applying the electro magnetic or magneto electric current (which latter I pre-

fer, as our object is to stimulate well the parts with as little trouble as possible to the patient); one good large sponge electrode is applied to the spine, while the other is moved slowly, firmly and gently in the direction of the rectum—or both electrodes may be alternately applied over the abdomen in the same direction in a rotary manner. I find this an excellent plan to remove flatulency. The earliest way of using electricity in these cases was, passing the current in the direction from the mouth to the anus, which in some cases have been successful, but it must be very disagreeable to the patient; or the current may be directed from the external parietes to the anus by passing a metallic conductor into the rectum, while a large sponge electrode is rotated over the abdomen. I have produced good results in this way, though in most cases I have found the external application from spine to abdomen sufficient. There are many affections of the bowels where we may use electricity with advantage. Dr. Christison, Sir J. Y. Simpson, and Dr. Cuming have narrated various remarkable cases treated in this way.

For paralysis of the rectum or sphincter ani, for incontinence of the faeces, for constipation or atony of the rectum, and for prolapses where the sphincters are debilitated or paralysed, the electrodes are to be directed to the sphincters

internally and externally—the inner part of rectum is but slightly sensitive to the current, while the mucus surface of the anus about the passage is extremely sensitive, a fact which it will be well to remember.

The rectum can also be cauterized as is done for hydatids, and other purposes.

To electrify the urethra, male genitals, &c., one electrode may be passed into the rectum, while the other, negative, is passed down the urethra to the stricture, the prostate gland, or vesiculæ seminales, as the case may be.

The urethral conductor must be well insulated with the exception of the metallic tip extremity; for otherwise the current would be lost over the surface of the urethra, and would be intensely painful, while it would not reach the part we wish to be acted on: the other conductor may occasionally be applied to the perinæum or over the coccyx. Where there is any inflammation or malignant disease present of course this procedure is inadmissible; but from incontinence of urine, from debility, impotency, loss of erectile power, or weakness of the seminal vesicles, or atony and debility of these parts, the electric current should be directed along the entire course of the urethra with as strong a current as can be borne for from five to ten minutes.

TO ELECTRIFY THE UTERUS, OVARIES, ETC.

The uterus may be stimulated to contraction by electricity, whether gravid or not. Experience of late has proved that the uterus of living woman contracts in toto, by the employment of the Galvanic and Faradaic currents. Dr. MacKenzie and others have demonstrated this on living pregnant animals. He ascertained that an electric current directed perpendicularly, *i. e.*, in a direction through the uterus from the fundus to the cervix, promotes powerful and general contractions; whereas currents passed transversely through the organ excite but partial contractions, and these limited to the fibres embraced between the electrodes. *Dr. MacKenzie insists that it is necessary to apply the positive pole to the nape of the neck, while the negative is at the cervix uteri, if we wish to act surely and energetically through the great sympathetic, upon the contractile fibre cells of the involuntary muscular substance of the uterus in any great emergency.*

Herder, Stein, and Killian, in Germany, Radford, Barnes, and others, in England, and several in France, have employed, and still recommend, the induction current, as an aid in midwifery practice, in cases of tedious labour;

in some forms of placenti previa, atonic hemorrhage from the uterus, post partim, and for causing uterine contractions, when necessary to induce premature labour.

Sir J. Y. Simpson, some years ago, was of opinion that the electrization of the uterus is all but useless. He *thinks*, whenever uterine action has been *apparently* excited by galvanism, it was a mere coincidence, or resulted from the impression made on the mind of the patients, or was produced by mechanical irritation of the uterus, or the abdominal parietes by the electrodes. I can see no force in these *opinions*, which, if that eminent physician still entertains, it is opposed to all reasonings ; and the experience of many of Dr. Mackenzie's experiments seem to confirm that, in cases of placenta previa, where profuse hemorrhage continues to recur, even where the plug and other means have been used, and before the os is dilated sufficiently to allow of manual assistance ; and, in cases of hemorrhage, in the early months of pregnancy, which resist other treatment, and which, from a constricted state of the os and cervix, do not admit of mechanical or manual interference, induction currents are an invaluable remedy.

As to the mode of applying it, Dr. Mackenzie advises us to apply the positive pole to

the nape of the neck, while the negative is introduced into the cervix uteri. Cleveland and Barnes direct the two poles to be applied over the abdominal parietes externally, while Dr. Radford advises one pole externally, and the other to the os uteri ; and Kilian recommends the application of a galvanic forceps, the blades of which are of two different metals.

In my opinion, there are a variety of ailments, to which women are subject, which ought to be amenable to the power of electro therapeutics. In amenorrhœa, its use, as an emmenagogue, is of great value. Cases are on record of young girls, who were threatened with phthisis, by determination of blood to the lungs, or where there is vicarious hemorrhage, or discharge, who were cured by a proper faradaic treatment. In Guy's hospital, the patients are treated by passing shocks from Leyden jars, through the pelvic region, from the sacrum to the symphysis pubis. But there can be no doubt, patients can be treated as well with the Faradaic electro-magnetic currents, as is practised by Duchenne, in France, who uses strong currents directed to the uterine organs. In some cases of chlorosis, also, this remedy can be used with great advantage.

Simpson's Galvano Pessary, as seen in Fig.

20, is made of various sizes. The stem, half way up, is made of zinc, and the remaining half, and the egg-shaped extremity is of copper. The stem is introduced into the uterus (in cases requiring it), while the egg-shaped extremity remains in the vagina. But, inasmuch as the secretion of the uterus is alkaline (in its normal state), it is doubtful whether a sufficient galvanic current is generated, so as to cause a reliable therapeutic current. The secretion of the vagina is acid, but none of this reaches the zinc, or intra-uterine element. So there is much reason to believe the action of this pessary is simply that of a mechanical irritant, notwithstanding the opinion of the eminent baronet, whose name it bears.

The *Heart, Stomach, Lungs, Kidneys, and Liver* may be stimulated, by reflex action, produced by applying the electrodes over the given organ ; or they may be directly acted on through the pneumo-gastric nerve. By applying one electrode (negative) to the upper and the lateral part of the pharynx, and the other (positive) electrode to the nape of the neck, all these organs will then be under the electric excitement. Or if we wish the current mainly to influence the stomach and liver, one electrode may be applied to the lower part of the æsophagus, and the other to the pit of the

stomach. The current must be moderate, of short duration, and frequent intermissions in each application.

FARADIZATION.

This term originated with Dr. Duchenne, in honor of the illustrious Faraday. He also was the first to introduce into practice the excitement of single muscles, or groups of muscles, by electric currents. However, many statements made in his large and popular work * appear to me far from explicit.

Dr. Duchenne distinguishes two classes of operations — the mediate and the immediate electrization of muscles. The first is to be performed through the nerve trunks, and the second is performed by applying the conductors over the muscles. The terms he makes use of are, the direct and the indirect muscular Faradization. In both cases the conductors are to be held close together, as shown in Fig. 15. Every muscle, or bundle of muscles, are to be made to contract singly by these moist electrodes, or excitors, as he calls them. Nothing, he says, is easier than this way of Faradizing.

The excitors should always be placed on the fleshy part of the muscles, close to the points

* "De l'Electrization Localisée, et de son Application à la Physiologie, la Pathologie, et la Thérapeutique." Paris, 1855.

of its surface, but never on a sinew or tendon.

For limiting the current in a muscle of smaller size, as the interossei, lumbricales, or the muscles of the face, he uses small conical excitors, or conductors, as at Fig. 16. When dry excitors are applied to the skin, that is also dry, he says there is produced a sensation of heat, or burning only; but if the skin is also thick, then there is no kind of sensation. If then the excitors are wet, and the skin also, there is neither spark, crepitation, nor heat produced, but a phenomena, according to the position of the conductors. If they are planted over a muscle, then there is contraction of that muscle, or at least a superficial portion of it, together with a sensation that is not peculiar to the skin, but that always, more or less, accompanies electro-muscular contraction. He defines this sensation as being like that produced by acting on a muscle that, for example, has been laid bare by a wound, so as to be no longer covered by the skin.

But it was left for Dr. Remak, of Berlin,* to point out, and for Dr. Ziemssen † to demon-

* "Über Methodische Electrisirung Gelähmter Muskelen." Berlin, 1856.

† "Die Electricität in der Medicine." Berlin, 1857.

strate clinically, and anatomically, the defined spots which are found to correspond with the points of entrance of the motor nerves into the lateral borders or edges of muscles. The latter marked on the skin of the patient, with nitrate of silver, such lines and spots as proved electro-muscular responsive,—to the there placed electrode,—and then, after death, by dissecting the motor nerve branches to their entrance into the bundles of muscular fibres, he thus found that these two series of experiments agreed with each other in every respect. Hence Remak and Ziemssen are both of opinion that there is no muscular contraction by exactly direct localized electrization of the muscles, as Dr. Duchenne claims, but contends, that in every case the contraction is brought about by the interposition or co-operation of the muscle nerve.

The trunk of the facial nerve (*portio dura*) can be reached from the external opening of the ear, or after the nerve passes from the stylo-mastoid foramen just under the ear, by applying one conductor between the *mastoid* and the *condyloid processes* of the lower jaw. But Duchenne says neither of these ways should be adopted in cases of paralysis of the *portio dura*, because from that point in the ear the feeble currents produce no effects on the muscles of

the face, while if we use sufficiently strong currents to produce an effect on the face muscles the electric stimulus is then conveyed invariably to the superficial *temporal*, or to the *auriculo temporal nerve* from the third branch of the trigeminal (tri-facial or fifth) nerve ; whereby a very annoying pain is also produced. He, for that reason, advises seeking the nerves, that branch from the *portio dura*, where they emerge from the parotid gland ; or else to limit the position of the conductors to the individual muscles that are affected. He finds some difference in the exact situation of these face motor nerves in some persons, but that, the electrodes will soon discover.

To act on the *brachial plexus*, the electrodes may be placed over the collar-bone in the supra-clavicular region ; if placed on the upper part of the supra-clavicular triangle they are then over the external branch of the spinal accessory nerve of Willis. The *phrenic nerve* is reached on the anterior surface of the *scalenus anticus*.

Dr. Duchenne also maintains that nerves and muscles possess very different degrees of excitability, and so we must regulate the strength of the current to their excitability. He also says there is a difference of muscular sensation in different muscles during contraction, which he terms "*muscular consciousness*."

To faradize the skin.—Three methods are adopted by Duchenne: the first is by the electric hand. That is, the operator takes one conductor in one hand, and the patient the other, while the disengaged hand or fingers of the operator is to be applied to the part of the patient requiring it. (The operator must remember the current is passing through himself and it might be injurious for this reason, and to avoid which, it could be applied by the fingers of the hand of the operator that holds the conductor). The second plan is by means of solid smooth metallic excitors placed in insulated handles, and to be moved over the surface of the skin requiring it, which in all cases must be well dried, except in some cases the soles of the feet and palms of the hands may be so horny that it will be well to use moist leather-covered excitors. The third plan, and the best, is that by means of the wire brush or whip (see fig. 14). The skin is to be quickly and lightly tapped or whipped over the surface of the skin; but sometimes it may be necessary to let them remain longer on the skin, as in paralysis of sensation. Duchenne recommends this for many cases of anaesthesia, neuralgia, and muscular rheumatism. As to the current to be used Benedikt advises the (secondary) Electro Magnetic in such cases; but any stimulating induc-

tion current will, in my mind, answer equally well, the object being direct stimulation of the skin. In many cases it is a most valuable procedure, and ought never to be omitted.

To faradize the ear, Duchenne advises the ear to be filled with warm water, but this is most difficult to be accomplished, and may be done quite as effectually as described at p. 103.

To faradize in partial amaurosis, loss of taste, and premature weakness, or dimness of sight, he advises the use of the continuous current (galvanization), "because it exercises a very much more remarkable effect on these organs than any induced current." I cannot reconcile this statement of Duchenne, who condemns the use of the continuous current in every other class of cases, and I should like to know how his numerous followers, who seem to take all his propositions without question, will reconcile this. In using galvanism to regions about the head of the patient (nerves, muscles, or any other part), care must be taken not to use a very strong current, from ten to fifteen cells of a Daniell's battery will be sufficient, and never more than from half to one minute at any time, unless the current be frequently interrupted.

No stronger current should be used, even if thought necessary, as most dangerous results might ensue, as has been before explained.

The faradizing of the *diaphragm* for the procuring of speedy artificial respiration is best performed (according to Duchenne) by applying one electrode over the *phrenic nerve*, which arises from the third, fourth, and fifth cervical pairs, and will be found on the anterior edge of the *scalenus anticus* muscle, and near the back of the middle of the *sterno-cleido-mastoideus*, while the other electrode is applied to the pit of the stomach; the current to be in the downward direction, and the electrodes to be large moist flat sponges. When artificial respiration is produced, the thorax heaves, the air rushing forcibly into the lungs; and it is quite possible to keep up this artificial respiratory process for some time, even after death itself. To establish and maintain this has often been to restore life, and in such cases as apparent drowning, strangulation, lightning, asphyxia, from accidents by chloroform, opium, carbonic acid gas, &c., is invaluable. The faradization of throat, pharynx, &c., has been pointed out at page 104.

Faradization of the mammae, by means of moistened sponge conductors, has been used by many, to cause the re-appearance of milk, which, by emotion, fright, &c., is stopped or diminished in one or both breasts. A few applications, for from ten to fifteen minutes, has been found sufficient.

CHAPTER VII.

THE GALVANIC BATH.

THE Galvanic Bath may be contrived as follows: the bath may be made of wood or of metal of the ordinary kind, protected by means of a sheet, or other non-conductor, it may be filled with water of any temperature, in which may be dissolved any compound, as bay salt, acids, or other substance.

A Pulvermacher's battery of from 120 to 200 elements—(there are chain batteries made for this special purpose)—these are to be excited by being drawn through vinegar, and hung up to a hook fixed in the wall, by its positive pole, attached by a piece of string; the negative pole should enter the water, but no portion of the chain (which should hang free) should touch the bath or sheet; by means of a wire attached to the hook at the positive pole, a conductor, with a moistened sponge inserted, can be placed

on any part of the patient that is in the water, thus the whole body, or a whole limb, or merely the foot, hand, etc., can be treated. A genial glow is soon experienced, an exhilaration of spirits takes place, *the secretions are freed*, and tone sooner or later may be secured. Here then is a bath, simply galvanic, or medico-galvanic, which can be produced at any time, in any place, and with little or no trouble; there is no shock felt except upon first placing the conductor on the patient, then a slight tremor pervades the system, after which nothing is felt.

I have been in the habit of using this bath for a variety of causes, and I believe it to be as useful an adjunct as it is simple; as a general stimulus in complete paralysis, in great exhaustion, from wasting diseases in the muscular atrophy of children, in scrofulous diseases of joints, tendons, etc., in gouty deposits, and in most cases where pain and want of tone exist. It may be taken any time when a person may not feel in his usual health, or during an epidemic, or an unusual electrical state of the atmosphere.

Becquerel has shewn that in all running water there is a flow of electricity passing between the earth and the water, and it is doubtless to this the good effects of cold river and sea bathing is to be attributed. A galvanic bath may be

also contrived with any other battery, and with good results.

ELECTRO CHEMICAL BATH.

A bath of this kind, after the manner of M. Poey is said to be capable of extracting various metallic substances out of the human body, where they have been taken as remedies, or lodged in the body by absorption, in the arts and trades in which they may be employed. A wonderful cure is recorded by him of an electro plater suffering from a dangerous ulcer which resisted the most energetic remedies.

It is administered in the following way: the patient is put up to his neck in a large metallic bath, which is filled with water and isolated from the ground; he sits in the bath on a bench of wood insulated from the bath, and having the length of the body. If mercury, silver, or gold, is to be extracted, the water in the bath is to be acidulated with nitric or hydrochloric acid; if lead, sulphuric acid is to be added. One end of the bath is connected with the negative pole of a pile of 30 pairs of plates by means of a screw; and the positive pole is held by the patient alternately in the right, and the left hand. The positive electrode is made of

iron, and covered with linen, so as to diminish the calorific effect of the current, which is very intense, and might cauterize the hand. The current then enters the body by the right or left arm, and circulates from the head to the feet, and according to M. Poey's account traverses all the internal organs, and even the bones, seizes upon any particle of metal that may exist, and deposits it on the side of the bath. Dr. Caplin of London (who has since improved these baths, and with M. Poey, in the year 1855, invented them), has given, in his many publications, various remarkable cures of very bad and long standing cases of patients well known in London and on the continent; and from my own experience it would be idle to say that in it we have one of the most important means of applying electricity.

I have examined the baths of Dr. Caplin, and have seen the metallic deposits which he describes, and having since (now two years) erected baths on his model, I have repeatedly seen, in the cases of patients who have taken mercury, iodide of potash, arsenic, and other metals, deposits of these metals on the baths, even though these medicines have been discontinued by the patient for years. I am of opinion, when the merits of this form of administering electricity is better known, the profession will find in it a

powerful means of removing inert matter from the system, and prove a specific in many forms of disease, in chronic rheumatism and gout, and in various classes of cases known as nervous debility. In some cases of long standing paralysis, in dyspepsia and constipation, in various diseases especially of a syphilitic character, when every medicine has been tried under the best medical advice, and in many other cases, I have found the best effects, and have often been truly surprised at the result.

[See page 166.]

CHAPTER VIII.

ELECTRO PUNCTURE.

In many obstinate cases of neuralgia, chronic rheumatism, local or long-standing paralysis, and other cases, where the electrical treatment has been indicated and have been found useless, or only partially successful, when treated even by skilled electricians, the application of Electro Puncture has been found, in the hands of many practitioners, to be most successful; and, with the view of inducing a more extended trial of this mode of electrization, a few cases in point may not be unacceptable.

This operation is performed, simply, by using the ordinary acu-puncture needles—as proposed by Sarlandière, in 1825—made of any unoxidisable metal ; platinized or gilt steel needles, very fine, well-tempered, and sharp-

pointed : and by stretching, or *pinching*, up the skin, with the thumb and fore-finger of the left hand, and then quickly passing in the needle, close to the thumb, in an oblique direction through the skin, we can then press it forward in any direction with more deliberation ; and experience proves that it is far less painful than patients anticipated. In the hospitals of Paris, acu-puncturation has been performed in a variety of ways, and for various affections, and, I have been told, without any unpleasant consequences, beyond some slight shock, prick, smarting, or occasional faintness, or pain, the rule being to avoid all seats of active inflammation. M. J. Cloquet is a great advocate of this procedure, even the puncture of nerves, he says, does no harm. The pain is trifling, and does not last ; and even should it be attended with any inconvenience, the needle may be withdrawn, and reinserted in another place. Indeed, numerous experiments and accidents prove that the purposed, or accidental, puncture of arteries or veins is followed by little or no inconvenience ; and if a few drops of blood should issue, it may be immediately stopped by pressure for a few seconds by the finger.

Acu-puncture, of itself, is thought, by many medical men of experience, to be nothing

less than actual electro-puncture, though no primary or secondary current be brought to bear on the inserted needles, which, passing through the skin and deep tissues beneath, act, it is said, *as conductors* for the insulated nerve, or chemical current, that has become morbid, and thus modifies the local action, and restores the equilibrium in the given spasm or painful part.

The electro-puncture needles, then, are to be looked on as sub-cutaneous electrodes, or conductors ; and my experience is, that for non-inflammatory pains, and some other cases that I have mentioned, where no other treatment has availed, we have here a mode of treatment as promising as any I know of, without being in the least degree painful or dangerous.

The needles should be from two to four inches in length, and, as a rule, the place where the pain may be felt is best to insert it, as in neuralgia, rheumatism, &c., or over the seat of palsy, dropsical effusion, gouty or rheumatic deposits, &c., but more often the seat of the anatomy and physiology will guide us better than any other. The number of needles to be inserted must be left to the judgment of the operator. From one to a dozen may, perhaps, be necessary, but the smaller number will meet the exigencies of most cases. These needles

may be brought in connexion with any battery, for the generation of the different forms of electricity by means of well insulated wires. Thus static, or frictional electricity, might be used ; or voltaic, or galvanic, or Faradaic electricity may be tried, but not with the same results. The experience I have had, is with the primary current, generated from the ordinary Daniell's battery, and of which the following few cases, that have been patients of my own, or have been sent to me for this treatment, by eminent medical men of Dublin.

Rheumatic Paralysis.—Case 1, æt. 34, a patient of Mr. M. Collis had suffered from acute rheumatism, from which she recovered, leaving a weakened condition of the left arm, and considerable loss of power. She can with difficulty raise the hand to her head ; sensibility is impaired, especially in the fingers and hand, and the temperature is very much less than in the other arm. She also complains of pain in different parts of the limb ; general health good. Faradization, by means of a magneto-electric apparatus, was tried, and with some trifling benefit. One acu-puncture needle was inserted over the deltoid muscle, and another over the biceps, and being connected with four cells of a Daniell's battery, the current was allowed to run in a downward direction—*i. e.*,

the positive to deltoid, and negative to biceps. The current was kept up for three minutes ; no perceptible contraction was experienced, but a glow of heat was felt. The upper needle was removed to the palm of the hand, near the fourth and fifth fingers, and the current was directed for three minutes more from the arm to the hand. This was repeated four times, with the current increased from 6 to 12 cells, and contractions were perceptible after the second application. The limb and hand regained their natural warmth and power, and the patient left town quite cured.

Scrivener's Palsey.—Case 2, a clerk, æt. 48, was sent to me for electrical treatment, by Dr. Hudson. He had lost all power over the flexors of the arm, and could not hold a pen, or write ; had been bad four months, and had Faradization applied by his usual medical attendant. I applied the continuous current, by means of Daniell's battery, for a week, each alternate day, with some benefit ; but as his time in town was limited, I determined on using galvano-puncture, which I did, over the flexor muscles, in a *down-running* direction, and with complete success, for he was, after the third application, able to write well, and he returned to his duties, in the country, quite cured.

Sciatica.—Case 3, had suffered from this painful affection for five years. She had Faradization applied for a length of time, with but little use. I used the galvano-puncture for six applications, and she has complained of no pain since the second application. I finished treating the case by galvanization of the sciatic for two weeks more. The patient has not complained of any pain since.

Spinal Neuralgia.—Case 4, who was a patient of the late Dr. Neligan, of Dublin, had suffered from a painful affection of the spine and hip. She had been treated by many medical men, and the induced current had been tried, by a practising medical electrician in Germany. She was altogether over nine years ailing. I applied the galvano-puncture in the region of the painful places, in gradually increasing doses, for six applications. She has had no pain since, and I finished the treatment with galvanization of the part. I may mention, that most of these patients have been advised to wear a Pulvermacher's chain-band, which I usually adopt in such cases, especially of a painful nature.

This practice of galvano- or electro-puncture, seems coming into use, and I certainly think deservedly so. I have never seen any dangerous results, as erysipelas, &c. (as pointed

out some years ago by an eminent surgeon in Dublin) when correctly performed with the proper needles, and the current suitably graduated; from four to fifteen cells of a Daniell's battery being about the strength, and from one to three minutes, the duration of each application.

ELECTROLYSIS.

A considerable amount of attention has of late been given to this process, which has for its purpose the decomposition of any substance, such as a tumor, hydrocele, &c., by the negative pole of a constant battery, such as Daniell's. It is well known that aneurisms can be coagulated by the positive pole of a galvanic battery, conducted by platinum, or gilt needles; while, if the negative wire be similarly applied, its chemical disintegrating effects is shown ; as, if we employ a current to act on a piece of raw beef, the place where the negative needle is placed will be entirely decomposed, and will be shown by a quantity of froth (alkaline). In this manner I operated on a case of cancer, in the groin of an old man, in the Meath Hospital, early in the year 1867, who was under the care of Mr. M. Collis, and the effect was, that a large slough was formed,

and a cavity left: the operation, but for other circumstances, and the age of the patient, would have been quite successful. In various kinds of tumors, the electrolytic treatment acts in three ways—1st. By mechanical disintegration, caused by nascent hydrogen ; 2nd. Chemical destruction, by the production of free alkali ; and, 3rdly. By the action of the constant galvanic current on the vaso motor nerves brought under its influence.

It has been proposed for the treatment of nævus, various kinds of cancer, and serous effusions. How far they have been successful I have no means of telling. I have cured several cases of hydrocele by its use,* and have no doubt, further experience will prove it to be of great use in various surgical affections. The battery I am in the habit of using is the modified form of Daniell's, described at page 13, which, I have no hesitation in saying, is the best and most constant for the purpose known; less likely to vary in intensity, and more to be relied on. It is also just as convenient for carrying about. I have seen and heard of many modifications of this battery, but have had no reason to change my opinion up to the present. It is well, in using currents of galva-

* See Medical Press and Circular, November 8th, 1867.

nism, to have different coloured insulators to the wires connected with the needles we may employ. Thus we may have black silk to the negative, or gutta percha ; and red or blue to the positive. In using it for tumors, &c., needles, the same as for electro-puncture, are employed. We may have one to six needles fixed on an insulated handle, and which is inserted in the part, or tumor, which is connected with the negative pole, while the positive is applied somewhere external, and in the region of the part, by means of a large sponge electrode.

CHAPTER IX.

THE TREATMENT OF NEURALGIA AND NEURALGIC AFFECTIONS.

It must be confessed that our knowledge of the exact functions of the nervous system is very incomplete ; and without attempting to explain the various theories of nerve batteries, nerve telegraphs, ganglia stations, and other nerve arrangements, whose disorganization, or want of equilibrium, causes such a train of symptoms, as to often cause the utmost perplexity in the mind of the general practitioner ; and, although we can arrive at a certain stage of certainty respecting the diagnosis of a case, we are very often perplexed as to the nature of some of these painful neuralgic affections. In speaking of *Hyperæsthesia*, and the diagnoses of diseases of the nervous system, and more especially of sensory nerves, Dr. T. Laycock says : “ *Pain* is pre-eminently the symptom

by which we become conscious of disease in the organism ; it is, in effect, the sentinel that warns us of impending danger."

By the term, "Hyperæsthesia," is meant that condition of the nerves, viz., an exalted susceptibility to impressions,—as expressed by tenderness and pain,—not because of any inflammation in the nerve, but by virtue of some change in the nerve tissues, in their route from centre to periphery, that may exalt its susceptibility. The pain, therefore, that may arise from a morbid condition of a nerve, and from a morbid condition of the tissues, may be quite different. One may be neuralgic sensibility, the other may be the pain and tenderness of inflammation.

The correct diagnosis of such conditions are of the utmost importance in the treatment of them. The seat of neuralgic *pain* is often in the termination twigs ; but that is seldom the seat of the *cause*. It is in the trunk of the nerve, or the tract of the cerebro-spinal axis, that we must look for it. In the pain of inflammation, the cause is always local, and shown by its characteristics. Any cause, which *exalts* the nervous function in any point, will give rise to hyperæsthesia, as mechanical injury, or contact, or congestion of the neurine. Nerves of sensation passing through foramina in the

bones, or winding around bones, or tendons, are particularly liable to this cause. Thus the nerves of the face are more subject to neuralgia than any other place. Spicula of bone, of cartilage, and other deposits, tumors pressing on the nerves, will all cause the same symptoms.

Hyperæsthesia of the vagus, or pneumogastric nerve, particularly of its œsophageal and gastric branches, is probably the most frequent of all neuralgic affections. We ought not to be surprised at this, when we remember how directly all mental operations act on these nerves, through the central axis—how quickly poisons taken into the circulation, re-act upon them ; how intimately connected is the viscera of the abdomen and pelvis ; and how continually the nerves of the stomach are exposed to the action of local irritants. We know irritation of the hand, as from a puncture or wound, will often cause inflammation of the whole limb, and will sometimes extend to the other limb, and even radiate to the nerves of the trunk. Therefore, we must not be surprised at any of these symptoms of this hyperæsthesia that may come under our notice, and may be known as *gastrodynia*, *pleurodynia*, *pyrosis*, *globus*, sympathetic affections of the heart and brain, called *palpitation*, *headache*,

and hypochondriasis. In some persons, particularly predisposed, we will have other symptoms, as nervous cough, asthma, &c., and others, *ad infinitum*.

In neuralgic pains and affections, when not complicated with organic lesion, the galvanic treatment holds out more likelihood of cure than any (I firmly believe) that has yet been discovered. I have met with many varieties of this affection, and unless complicated with organic lesion I have never known it to fail; indeed I believe it is all but a specific. I have known it to cure patients who were suffering for numbers of years without even a probability of cure being held out to them. Of course cases will arise where no form of treatment will avail, a rare feature in my experience of these diseases. It will be my object in this chapter to point out the most approved, and from practical experience found to be the best, method of treatment in such cases. Neuralgia is generally a stabbing, plunging, pain in a part, or it may be a stinging, pricking, or shooting pain, or a violent itching pain; of such is the pain of the sciatic nerve, known by the name of *sciatica*. It may sometimes arise from inflammation; being a greatly exposed nerve it frequently becomes affected with rheumatism from cold, wet, or damp, after great fatigue, or heat, so that a

morbid action may be set up which may amount to a neuralgic or rheumatic inflammation. It also is not an unfrequent concomitant on many paralytic affections; but sciatic neuralgia may be caused by some morbid irritation of the alimentary canal, or pelvic viscera, and so be only a reflex nervous action; then after the cause is removed the pain appears to be chronic, the same as paralysis of the limbs continues after the lesion of the brain has been healed, (which was the primary cause).

It is thus all important to distinguish the organic from the symptomatic sciatica, of course it is not to be supposed that the advocates of electro therapeutics will say that in such cases of organic sciatica it is advisable to use this remedy. We must be guided by the well-known laws of general therapeutics. No form of electricity is found useful in acute inflammatory sciatica, unless it be actively employed within the first twelve hours or so after the sensation of coldness, numbness and weight in the limbs, and the rigours are inaugurating the attack; when it very often, as I have seen, put a stop to the attack; but for others we must be guided by the usual antiphlogistic treatment of such cases. When these cases are treated in the usual way pain and other symptoms not unfrequently remain; then we must apply the

direct galvanic or faradaic current which will be found to be the most effectual means of clearing the nerve roots of any remaining congestion, which by catalysis it will certainly accomplish.

Acute sciatica may occur from a variety of causes, and may always be relieved by the proper administration of galvanism. In these true neuralgic affections of the nerves the continuous current, as generated from a Daniell's or a Pulvermacher's battery, has given me the best results; sometimes the Faradaic current (electro-magnetic) will be an important aid; but there is another class of true hyperæsthesia known by the name of affections classed as true *hysteria*, which shows itself by pains in the muscles and the head (cephalalgia), or of the back (rachialgia), or the muscles of the epigastrium (epigastralgia), or in fact any other part of the body; these affections of true hysterical hyperæsthesia, are quickly cured by the local application of Faradaism; and it is in these cases that we are only to apply a current stronger than the patient can bear (even if done under chloroform, as advised by Benedikt) who has seen the best results follow from it.

There are so many classes of neuralgic affections that it would be impossible to even glance

at them all, but the principle of cure is the same; in the treatment of them with any of the forms of electricity I adopt one of two rules, as follows:—

For pains in the lower extremities in bad cases.—If the limb is cold, soft, and with bad circulation, and if there is pain, weakness, and stiffness about the hip and thigh, or only about or above the knee-joint, or if the foot and ankle is weak and painful, apply the current in the down-running direction, commencing cautiously with a gentle current, and using large sponge electrodes well-moistened in water, or acidulated water; begin by applying one of these conductors (the positive) over the entrance of the sciatic nerve, or under the coccyx, or on the lumbar vertebræ adjoining, or whichever may be the most tender spot, occasionally varying the position according to the symptoms that may be produced; and at the same time apply the other conductor (the negative) into the popliteal space, where it must be held firmly for say half a minute at a time, gradually increasing the current, then moving it along to the *external peroneal* nerve without diminishing the current; then still move it to the *extensor digitorum* with the full bearable current; then we must wipe over the calf of the leg for a minute or two; then to the outer joint, and to

the toes without changing the current: the negative electrode must be allowed to rest here, and then begin to glide the other (positive) downwards from place to place as has been done with the negative conductor, following in all cases the course of the nerves. If the pain, weakness, or contraction be on the inner and anterior part of the leg the same principle is indicated, and if it proceeds from the abdominal ring, crest of ilium, or femoro crural nerve to the inner side of knee-joint then the electrode must be so placed, always remembering to have the positive pole at the upper part and the negative below.

In cases of arthritic rheumatism the current must be directed through the joint. If the case is a mixed one, or does not get better with say half a dozen of these applications, then we must try the following rule, No. 2.

If the painful limb is plump, solid, and warm, with pain anywhere about the nerve track, especially the knee, calf, or foot, then we must apply the current in an inverse or *up-running* direction, *i. e.*, the positive below and the negative above, observing the same rules as in the last case, only reversing the order of procedure. From these two rules we will be enabled to treat all manner of neuralgias amenable to treatment with success. I usually make use of the Daniell's

battery, sometimes alternated with the induced current; and I generally in suitable cases direct my patients to wear a Pulvermacher chain band.

In neuralgic pains in the upper limbs the treatment is to be carried out exactly the same as for the lower, in one of two ways—the up or down-running direction; in the latter case the positive pole is applied near the head, and the negative over the nerve trunk nearest to it, and glided from nerve to nerve as was done in the lower extremity, while the inverse or up-running current is performed the reverse way, *i.e.* the positive furthest away from the head.

It will be well to give a few cases in point, which have been treated by me in this way.

Case 5, æt. 56, the mother of several children, suffering from periodic sciatica for the past nine years, had been under several eminent medical men of various countries, and tried many methods of cure but without avail, she gave herself up as hopelessly incurable, and at the instigation of a friend I was sent for. Her right leg is considerably contracted and wasted, severe pain along the leg from the sciatic downward, periodically on a change of weather, and at other times; not a month elapses but she has a severe attack, which usually lasts from two to five days; her general

health is good, bowels inclined to be constipated. I passed a stream of galvanism from 24 cells of a Daniell's battery in a down-running direction for ten minutes, and directed the patient to wear one of Pulvermacher's chain bands. The galvanization was continued for a fortnight three times a week, and the induced current (Faradaic) was applied for another fortnight; she wears the chain band constantly, and from the first application to the present time, now over four years ago, she has never felt any pain; the condition of the leg is much improved, she can walk well with the aid of a stick, and the only precaution she adopts is the constant wearing of the chain bands.

Without entering into the different forms of sciatica after it has passed its inflammatory or acute type, and when it has merged into a chronic stage, for the pure neuralgic sciatica, for the gouty and rheumatic form of the complaint, it may be safely affirmed that galvanization, and sometimes faradization, offers the most likely hope of a perfect cure. I have seen the proper use of it attended with the most marvellous effects, even when all the results of modern therapeutics have been brought into use, after all the well known internal remedies had been tried, as well as the various

external applications, and also the hypodermic injections of various sedatives, etc.

Case 6.—Rheumatic Sciatica. A farmer in the Co. Tipperary consulted me respecting this complaint, he had been suffering for several years, has had many attacks of rheumatism from exposure in following his usual avocations; the right leg was much wasted, and he suffered much pain in the course of the great nerves of the leg. A course of galvanization and faradization has completely cured him, and in three months time his right leg was as strong as the left, nor has it troubled him since.

“Tic douloureux” or facial neuralgia is a disease which, especially among females, seems greatly on the increase of late years, probably owing to the exposed manner in which our fashionable ladies expose their head and face at all times.

The seat of the suffering is generally in one of the three branches of the tri-facial nerve (the fifth pair), and usually runs along its ramifications, so that the exact spot of pain can be pointed out by the patient. It is more frequently situated in the two upper branches than in the lower or inferio maxillary; when seated in the first or ophthalmic branch, the frontal ramifications of it are oftener affected (brow-

ague, or *clavus hystericus*) than the nasal or lachrymal branches; but in some cases all of them are affected. There may be intense pain in the eye and an abundant secretion of tears; in fact the pain may attack all these nerves of the face; sometimes the dental is affected, giving rise to the most awful form of tooth-ache; sometimes the lingual branch, giving intense agony in the tongue; or in the temporal, causing excruciating agony in the temples. All of these forms of tic I have seen, and I assert without fear of contradiction, *that I never failed to cure a case*, no matter of how long standing, unless as before stated, the seat of the cause of the disease was *intracranial*, or the disease itself was caused by *organic* change, as cancer of the muralema of the nerve, the pressure of a bony growth on the nerve, or disease of the bone itself: of these two I know of incurable cases in Dublin, and of course they must always remain so; but many of the former classes of intracranial origin can be successfully treated, as has been affirmed by Benedikt, Meyer, and other writers. The proper and only treatment to be adopted is the galvanic. In some recent cases I have had some really magical effects from the use of Pulvermacher's magnesium battery, of which the following two examples are good ones:—

Case 7, Miss P., was a great martyr for five weeks to this painful affection of face and temples. A Pulvermacher's battery was applied (positive to painful nerves, and negative pole to spine) for ten minutes at each place on the face, half an hour altogether each time. The pain entirely left her, and she slept well that night, and has had no return.

Case 8.—Mr. C. travelled up, six weeks ago, from Cork to Dublin, by night mail, and was imprudent in not guarding his face from drafts of wind through the railway carriage. He had been suffering intolerable agony all this time, and the same treatment as in the former case proved eminently successful, without any relapse.

Another equally remarkable case (9) is that of a well-known architect in Dublin, who, while travelling from Galway, in the same way, was suffering for several weeks, and was cured by *one application* of Pulvermacher's magnesium battery.

These cases are not given with any idea of boasting, but I will be at any time happy to refer any person, who doubts these facts, to the patients themselves. A few more chronic cases are given.

Case 10.—The Rev. Mr. D., of Somersetshire, at 60, had been a martyr to facial neuralgia

for over ten years, and had not been able to preach for some time, in consequence ; (the constitution gouty), and was a most unpromising case. Galvanization was used constantly for six weeks, with alternate applications of the induced current, and it is now some three years since he has had any return of pain.

Otalgia, or ear-ache, *Odontalgia*, or tooth-ache, and also many cases of headache, distressingly painful as they are, may be, and often are, simply neuralgia. Many such have, in my practice, been speedily cured by any battery, as is frequently done in my establishment for the poor and others so applying. Care must, of course, in all these cases of facial affections, be taken when applying galvanism near the eye, as violent inflammation of the retina might be caused, if persisted in for any length of time, and with too strong a current. Also avoid, if possible, or use a very gentle current to, the forehead with an electrode, because the periostium of the bone is so near the skin that great pain is produced.

If pain should return persistently after repeated applications, particularly about the face, we may conclude that, in all probability, it is caused by organic disease.

There are some forms of *cephalalgia*, that occur about the back of the head and neck,

which may arise from a disguised neuralgic state of the occipital or supra orbital nerves, or the ganglionic nerves of the head, which I have cured by applying a large sponge electrode over the lumbar region, low down, while the other (*positive*) is applied to the cervical region, increasing the current to what can be borne. This must be rubbed over the shoulders, neck, and base of the skull for a minute or so ; or, if the pain be situated on the crown of the head, apply the other electrode there for a few minutes, if the patient can bear it. Sometimes it is well to change the position of the negative pole to the epigastric region, *but not when the positive is on the top of the head*, in which case the negative must always be on the spine.

Duchenne recommends for several forms of neuralgia, faradization of the skin of the most painful character ; and he treats sciatica, &c., by applying sudden and acute shocks to very sensitive parts, such as the helix of the ear, or the nasal septum. No doubt, in recent or hysterical cases, this form of procedure may be successful ; also where the seat of the disease is very superficial ; but the best authorities agree in advising that, unless for *hysterical neuralgia*, a painful current should *never be used*. My experience is, that the faradaic cur-

rent is far inferior for the cure of all classes of neuralgia than the continuous current.

In hysterical affections, generally including this form of neuralgia, the patients bear faradization far better, and with more courage, than men ; but some cases are so susceptible, that even the most feeble current will bring on a violent paroxysm. In such cases, chloroform should be administered, which will in no way impede the revulsive effects it is intended to produce. But faradization is a means, in my mind, which should never be used until the other form has failed. Neuralgia may occupy the seat of any of the nerves of the body, but the most superficial are those we are usually called upon to treat. Sometimes they occur in deep-seated parts, and the causes may be obscure. General constitutional treatment must, in all such cases, be adopted. Nor does the author intend that this form of treatment should interfere with the proper therapeutic means which should always be used. *The electro therapeutic treatment must, in all cases, be looked on as a powerful adjunct to other well-known means.*

Various other cases of neuralgia of the spinal nerves, neuralgia of joints, sheaths of bones, &c., whether of a neuralgic or rheumatic character, will all be beneficially treated in this

way ; also various obscure internal neuralgias, of the uterus, stomach, &c. Space does not permit of cases in point being described.

Chronic Rheumatism, of almost every description, whether seated in the lining membranes of joints and bursæ of tendons, or when it attacks the feet, the hands, the hips, or shoulders, knees, elbows, or any other joint, or the muscles, *facia*, or *periostium* of the skull, vertibræ, or bones, all of them are wonderfully amenable to the catalytical effects of galvanism, or the disturbing power of *fardization*. *Recent* effusions of joints are surprisingly removed by the continuous current, and even some long-standing cases have been cured by galvanization, which has a much more solvent power in these cases than the induced current. Dr. Benedikt gives some truly remarkable cases of cure in *Rheumatic Gout*, and in cases requiring the removal of solid and fluid exudations from joints by galvanization.

In the various conditions of hyperæsthesia, occurring in *Hysteria*, as pains in various superficial muscles, which are always to be known by the pain being felt immediately beneath the skin, and with slight pressure or scratching will aggravate it, and will often

induce a paroxysm. Under the influence of proper faradization, these pains, when non-inflammatory, are quickly removed.

Non-inflammatory pains, whether in men or women, are found to be rapidly removed in this way. Faradization of the skin, as performed by Duchenne, has also been eminently useful. In applying galvanism or faradization for affections of joints, the current should be directed through the joints, and with as strong a current as can be borne, always using well-moistened electrodes.

In applying the various currents in the directions of the nerves, the anatomical position of them should always be our guide, as also through the muscles, which we should *always remember*. In no branch of medicine or surgery does a correct knowledge of anatomy require our most serious remembrance than in the proper application of this agent.

CHAPTER X.

THE TREATMENT OF PARALYSIS.

RULE 1. When we suspect any existing central lesion, or have any doubt whatever of the case arising from such central disease, we must not use any faradaic currents, or any reversions, or intermittencies of the galvanic current ; but, if the case is deemed suitable, we must apply a gentle galvanic current, as is generated from a Daniell's battery, which is explained at page 13, so as not to disturb very much the brain or spinal marrow, as is done in the direct manner, as explained in the treatment of neuralgia.

Rule 2. We must remember that if the current is sent in the *down-running* direction (*direct*), the effect is a modified polarity of the muscles and nerves so embraced. There is *less* nervous action at or about the positive electrode, while there is an *increased nervous*

action at, about, and *above* the negative pole.

Rule 3. And that the results will be the same, but *reversed*, if the current be *reversed*, so as to be in an *up-running* direction (*inverse*), then we will have diminished action below, increased action above (*i. e., at the negative*).

Rule 4. The effect is also greatly increased if we suddenly *reverse* or *interrupt* the current, as is done by the metallic key-board of the galvanic battery.

Thus we will cause more central effect if we suddenly interrupt the current, or reverse it, or twitch the muscles by it ; and still greater, if the current be directed towards the head (in an *up-running* direction), as when the negative electrode is about the neck or head. This is the reason why the electro-magnetic, or any other of the forms of the induced current, should not be used in paralysis depending on a central cause. In suitable cases of such, galvanization, as directed, will be a great aid towards recovery. Dr. Benedikt advocates this, as well as others in this field of study. So that, if a case of paralysis of the arm or hand presents itself, the *negative* electrode is to be applied over the brachial plexus of nerves, or the median nerve, and the *positive* is

to be applied and worked (with a strong current) over the neck and dorsal region of the back, and also over the muscles of the chest and shoulders for a few minutes ; and then, applying the positive pole stationary on the plexus, or nerve (median), make frequent passes and *interruptions* in the current as will bring the affected muscles into full action (contraction) for a few minutes more. Sometimes the treatment is beneficially concluded after such a *seance*, by faradization.

If any of the muscles of the leg or foot be paralyzed, the negative electrode must first be applied over the ischiatic, or femora-crural nerve (according to the seat of disease), and with the positive, the spine is to be well bathed, including the back, muscles, and bowels, using as strong a current as can be borne, after which the positive electrode is to be applied stationary over the nerve where the negative has been, while the negative is made to make passes over the different affected muscles, in an oblique direction, with such a current as to make them contract. This must always be done without causing much pain, especially where the muscles are sick and weak. The electrification of muscles generally has been pointed out on page 82, with Duchenne's *rules*, but the above is certainly the least pain-

ful manner, and, according to my experience, is the best.

With respect to faradization of the muscles, the rule is to faradize when the electro-contractility is diminished or exhausted ; then the faradization of these muscles will do good. But when the electro-contractility is unaffected, it will not be of any use.

The diagnosis, then, of a case of paralysis will determine whether we are to use a faradaic current, and such a diagnosis should be made in every case, and each muscle examined, *except only* in cases of *cerebral* origin. The condition of muscles following some lesions of the spinal cord, and the paralysis of infancy, arising from various causes, as teething, &c., may be beneficially treated, or their treatment aided by faradization.

Local paralysis, from the injury of a nerve, or rheumatic condition of the nerves, which will give rise to paralysis, are beneficially treated by faradization.

There are many cases of so-called wasting paralysis (progressive muscular atrophy). In these cases the palsy depends on loss or waste of the muscular tissues, which, as a rule, remain normal, and respond well to the faradaic current. In some of these cases it is a most valuable remedy, preventing the progress of the dis-

ease, and promoting the growth of the sickly muscles.

Of all the remedies which art has placed at our disposal, none can bear comparison with galvanization and faradization, in the treatment of those forms of paralysis which originate from rheumatism, and from poisoning by lead. The following cases will serve as good examples.

Case 11.—*Rheumatic paralysis of the face.*—Miss —, of middle age, strong, healthy constitution, was suffering with paralysis of all the muscles of the right side of face, brought on by exposure while travelling, presenting all the well-known characteristics. She had been under treatment for some time, and was, by the advice of Dr. J. Hamilton, of Dublin, sent to me for treatment. Galvanization and faradization were applied for three weeks, and with marked benefit. She gradually regained the use of all the muscles, and left town perfectly cured.

Case 12.—Mr. G. first suffered from violent neuralgia, for which, by medical advice, he applied many sedative and stimulant applications and internal remedies ; after nine months' time it ended in complete paralysis of the right side of the face, for which he consulted Dr. Hudson, of Dublin, who advised

him to consult me, with a view to its treatment by electricity. Galvanization and faradization were used, and in some time (the case being chronic) the patient regained the complete use of all the muscles, and was quite cured.

Case 13.—Mr. M., who had suffered from rheumatism, had lost all power over the extensors of the fore-arm. He consulted Dr. Hudson for it, who advised faradization, and sent him to me for that purpose, which, in twelve applications completely cured him; and he now uses his arm, and writes well, which he could not do before.

Case 14.—Mr. F., painter, suffering from lead palsy for some time, was in one of the hospitals of Dublin, and had faradization performed, with other treatment. He could not use his right arm, and had complete wrist-drop. The extensors of the fore-arm, the triceps, and deltoid were also much wasted. He was put under a course of galvanization, and in five weeks the power of the arm began to return, and in two months he was able to do some work. He finally got quite well.

Some say, in a work like this, successful cases only are given. In order to show examples of incurable cases of facial paralysis that came under my notice, I give the following :—

Case 15.—Mr. ——, of middle age, suffered from complete facial palsy of right side, and had the best treatment by eminent men in England and Ireland. He consulted Sir D. Corrigan, who sent him to me, not with a view of being cured, but to be relieved of the intense pain (neuralgic) which he suffered. There was evident disease of the petrous portion of the temporal bone. Very feeble galvanic streams could be borne, but they relieved the pain ; the paralysis, of course, remained, and will remain as long as the unfortunate sufferer lives.

A similar case (16) was sent to me, under the same circumstances, by Dr. Hudson, in 1867—a commercial man, well known in Dublin. The most feeble galvanic or any other current could not be borne, and the patient only lived a very short time after he came under my notice.

The following unpromising case (17) of Hemiplegia was, in consultation with Dr. Wilmot, of Dublin, treated by me. Mr. F., who had an apoplectic attack, and recovered from it, leaving the entire right side completely paralyzed. He had lost all power over his right arm and leg, and went about in a bath-chair for nearly two years. The muscles were very much wasted, and temperature diminished. Dr. Wilmot suspected cancer of a

portion of the brain, which, from the appearance of the patient, seemed probable. By repeated applications of the galvanic and Faradaic currents the patient in six months was able to walk about. He gradually recovered the use of both arm and leg, and though there is some stiffness (as there is still a clot of blood in the brain), the patient is able to attend to business.

I have treated some cases of congenital paralysis, where the little patient never was able to walk from birth, probably from spinal disease, some of them with success; one of which, a child, æt. 7, a patient of Mr. Adams, of Dublin. A case (19) is under my care at present, of a child, 13 years old, who up to six months ago never could walk. She does so now, with the aid of a crutch or stick, and I have every hope of being able to effect a cure.

Some cases of *muscular contractions and club foot* arise from paralysis of a particular muscle, or set of muscles, which, when divided, the antagonistic muscles themselves become contracted, or paralyzed. The treatment in such cases is clear enough, on the galvanic principle, and in my experience has been in many cases completely successful. The muscles which are contracted and paralyzed, are to be stimulated to contraction by the induced

current, while galvanization is to be also performed until they yield. In such cases I find the wearing of Pulvermacher's chain-bands to greatly aid in recovery from these deformities; the foot regains its perfect strength—a fact which cannot be said for the usual surgical means.

Curvature of the spine, from debility of muscles, caused by awkward habits, or stooping, and in young ladies, from badly-made corsets, may by this treatment be perfectly cured. Also, numerous cases of *wry-neck*, sometimes hysterical, are speedily cured by Faradization. A very chronic case (20) of this kind, in which there was great deformity and rigidity of the muscles of the neck, chest, and back, a patient of Dr. Hudson, who advised this treatment, which in a short time completely cured her.

In *infantile paralysis*, *partial paralysis*, *ptosis*, or drooping of the eyelid, it has been used with success. Space will not permit of any of these cases being narrated. In paralysis of other parts, the reader is referred to those in the Galvanization or Faradization of such.

The object of these papers being more to extend the use of this remedy in hospital and private practice, the author believes that more

attention should be given to this subject, and not leave it till every other remedy has been tried. Patients and others will bear in mind the great disadvantage that arises from chronic cases being presented for treatment, which, when in the acute stage, would have been rapidly cured.

Very many other affections are amenable to the proper uses of electricity ; thus, various forms of spasms and cramps, as chorea, "St. Vitus's dance," many forms of hysterical cramps, contractions, and affections, some forms of convulsions in children and adults, are speedily cured or relieved. The trembling of ague I have seen stopped at once ; also that from the poison of alcoholic drinks, after *delirium tremens* had been relieved ; and in the early form of this affection, I have produced sleep by the application of the magnesium (Pulvermacher's) battery to the temples, even when large quantities of sedatives had been given, thus proving its calmative power. In many forms of nervous excitement I have caused sleep over and over again ; and I know a clergyman, in the county Cork, who frequently adopts this plan, and always with success. Also in the delirium of fever it sometimes has an almost magical effect.—(See cases in *Medical Press*, 1863, vol. 7).

In many cases of so-called *nervous debility* and *hypochondriasis*, by attention to the morbid organs, good effects will follow.

In *asthma*, most cases will be found to be greatly relieved or cured. Many cases of this kind have been successfully treated by me.

In some forms of incipient, or chronic, *phthisis*, and Bronchitis the proper application to the chest of the galvanic and induced currents, will go a great way in aiding other means, of which I have seen some good examples.

In *croup*, I have often stopped a paroxysm, as also in the fits of *hooping-cough*. In many forms of spasms of the heart (angina), the electric treatment will dispel the fit. In some cases of tetanus, also, this treatment has proved of service. And in some forms of *epilepsy* (especially of the hysterical kind), great good has been attained.

It would be difficult to tell in what form of disease a remedy so potent as electricity would be indicated, seeing that it is a stimulant, a powerful tonic, sedative, and antispasmodic, and by its mechanical and chemical action may remove disease when all other remedies fail.

CHAPTER XI.

DISEASES OF CHILDREN.

IN addition to what has been already said about the diseases of infancy and childhood, including those of a paralytic tendency, I would wish to draw the attention of the profession to the following, which has been reproduced from *The Medical Press and Circular* of November 15, 1871.

DR. ULLERSBERGER ON ELECTRICITY IN DISEASES OF CHILDREN.

A prize having been offered by the Editor of the *American Journal of Obstetrics* for an essay on the use of electricity in the treatment of the diseases of children, it was won by Dr. Ullersberger, of Paris, and his elaborate essay, translated by Dr. McLean Hamilton, is appearing in the pages of our valuable contemporary.

The following is an abstract of the prize essay in question :—

The notable advantages of the remedy are :

First: The patient has little or no fear or aversion to this mode of treatment.

Second : It admits of the possibility of modifying the degree of application.

Third : It is impossible to produce the special lesions of the skin.

Fourth : There are means of applying this remedy on all parts of the body, even to the most inaccessible.

Fifth: The operation of electrization occupies very little time, is of short duration, and requires but few preparations.

Sixth : The operation, after being performed, does not leave pain like the cautery, and all the revulsions of more or less intense effect.

The enumeration of the advantages of electric medication leads us to the question : " What is then, the general effect of medical electrization ? " Its effect is to *invigorate and stimulate those nerves* whose function has been weakened ; to calm the irritable or irritated nerves ; to compel paralysed nerves to contract ; and to restore tetanised nerves. It stimulates or suppresses the glandular secretions ; it can change solid matters so as to favour their absorption ; and will bring together material for the formation of solid matter—*i.e.*, in checking muscular atrophy. A continuous application of electricity excites con-

traction of the fibres of cellular and connective tissue ; it increases the activity of the lymphatics, causes contraction of the capillaries, and increases the tone of the vessels.

Electricity, when used in medicine, is applied in four different ways :

1. *By Frictional Electricity* (rubbing).

2. *By contact* (galvanism). Of the electricity of contact the following currents are used in preference, and to accomplish the following results. (a.) An electro-dynamic current, in order to change the action of the nervous system ; (b.) an electro-chemical, for producing decomposition reduction, oxidation, precipitation, and coagulation ; (c.) an electro-thermal, for calorification, cauterizing, and destroying by heat.

3. *By Magnetism* (electro-magnetism) ; and finally,

4. *By Electricity*.

The two last modes of inducted electricity (Faradization) can only be employed when the currents intermit to produce shocks, irritation of the nervous system, and of the contractile tissues.

The action of the constant current (*dynamic electricity*) on the motor nerves, was made known by Remak ;* previously Nobili, Matteucci, and Eckhardt, had observed that a continuous galvanic

* Robert Remak : "Galvanotherapie der Nerven- und Muskelkrankheiten." Berlin, 1858. 8vo.

current which was used for stimulating rendered a part of a nerve insensible. By this discovery Remak profited, and he used the current to cause contractions for overcoming shortening. A current of 30 elements of Daniel, conducted for several moments through certain contracted muscles, produced a mollification, and re-established the will over the flexors. When used in shortening, deviation, contraction of the muscles and paralysis, great improvement was manifested in a few minutes; in other cases it was of no avail.

The mollification and relaxation of such contractions are now constantly effected. The electric current acts as a stimulant on all the sensory nerves, and is consequently applicable in all cases in which stimuli are generally indicated.

The degree and duration of stimulation should be proportioned to the individual susceptibility. In an irritable individual it is necessary to commence with a current of the least intensity and duration. It follows that congestions, inflammations, and feverish affections form contraindications.

But what then is the effect of the constant current? * It increases the conductivity of the

* Comp. Dr. H. G. Hammar, director der electrischen Heilanstadt zu Dresden: "Die Electricität als fortlanfende bildende und erhaltende Kraft." Dresden, 1855. 8vo.

muscle ; it is an excitor of the nerves and muscles ; it penetrates and agitates, and as a diffusive stimulant, congests the tissues it traverses.

The general effects are the following :

1. Increased supply of blood with simultaneous elevation of the temperature of the parts under electric stimulation.
2. Increased energy of the contractile power of the walls of the vessels.
3. The electric current prevents and overcomes these changes, secondary and consecutive, which are manifested by inactivity of the nervous and muscular radii.
4. It re-establishes the lost or suspended power of the nerves, and it consequently stimulates innervation.
5. It is capable of provoking a supplementary activity in the non-paralysed nerves. We can use the electric current as an excitor of the muscular power in paralytic affections.

It is precisely in such cases that it has been heretofore employed, as also in cases of anaesthesia or lost sensibility.

Electric stimulation is capable of restoring, under certain conditions, the vital energy of the motor-nerves and muscles, when weakened or entirely suspended.

It can regulate or effect material transformation in the parts mentioned.

Electricity exerts a special effort on the systems of locomotion and nutrition ; it exerts a reflex compensation.

Stimulated innervation can produce absolutely the same physiological phenomenon as electrification—that is to say, elevation of temperature ; acceleration of pulse ; division of fluids ; increase of the secretions and excretions ; congestion of the skin and contraction of the muscles.

METHODS OF THERAPEUTICAL ELECTRIZATION.

Medical electricity comprises statical electricity, electricity by contact, electric bath, electric spark, discharge by the Leyden jar, electric blowing, electricity by the brush or the pincers. Electrization by these modes is very rarely employed. The dynamic, which is divided into—

1. Electricity by contact (galvanism), subdivided into (*a*) continuous current, (*b*) an intermitting current.

2. Inducted electricity (Faradization), thus called by Duchenne of Boulogne, after the name of the inventor.

They take their source either from a galvanic column (apparatus of Volta, electric or electric-dynamic,) or by magnetism (rotatory magneto-electric apparatus).

METHODS OF LOCALISED ELECTRIZATION,
LOCALISED FARADIZATION.

1. Electric irritation of the skin. We Faradize the skin, (*a*) by means of the electric hand, (*b*) by means of the metallic excitors, (*c*) by means of the electric wires, electric flagellation, or on a single point the electric moxa.

2. Electric irritation of the muscles, muscular Faradization, which is direct, or indirect Faradization of a nerve or muscle in the normal state, produces always a contraction, or sensation. The indirect presupposes an exact knowledge of the position and the direction of the nerves. The muscular consists in that each individual muscle is contracted; when we become aware of this when we place the damp electrode over the parts of the skin which correspond to the surface of the muscle. Electricity, under the influence of very strong currents, can penetrate deeply in the tissues.

3. Faradization of the internal organs: the organs of sense; the genital parts of man; the rectum; the anus; the pharynx; the oesophagus; the bladder; the larynx. The Faradization of these parts requires special instruments.

Faradization of the stomach, lungs, or heart, is only affected by the indirect Faradization of the pneumogastric. Faradization, applied to the

treatment of disease, should be applied every day, or every other day. It is not well to prolong the *séances* more than 10 or 15 minutes. We apply it in centrifugal or centripetal currents, or by irritating the peripheral ends of the nerves by the electric currents.

Localised electrization consists then in this: that the effect of the electric current is confined to the skin, a branch of a nerve, or a nerve-fibre, a single muscular fasciculus, or finally to the internal organs, by irritating directly or indirectly their nerves. These operations do not injure the skin, and we use in their performance wet or dry metallic excitors (sponges in metallic cylinder).

In one instance the dry metallic excitators only produce on the skin an irritation limited to it; in the other, the wet excitators, applied to the wet skin, cause the electric currents to penetrate the skin without irritating it, and diffuses them through the organs immediately beneath.

We have as established galvano-therapeutical rules, the following :

1. The descending extra polar electronus should be in preference employed, when it is desirable to restore a pathological excitability, an anomaly if irritability, around the peripheres of the nerves, to their normal state.

2. The extra polar catelectronus, on the con-

trary, should be used where lowered excitability or diminished excitation exists at the periphery of the nerves, that is to say, the muscles that are to be restored.

3. The indication for the production of the anelectronus and of a localised ascending catelectronus, should start absolutely from the same point of view. The electronus is in general contraindicated in increased excitability, while the other, the catelectronus, is contraindicated in diminution of excitability in the central part of the nerves—in the central spinal ramifications and the roots of origin of the nervous fibres.

We have characterised the therapeutical value of the currents of tension "*die spannung stromme*" in the following manner :

1. They are able to render the same service as the Faradaic currents.

2. Against complete paralysis of sensation of the integument, the currents of tension separated a certain distance from the skin, operate with much more force than the Faradaic and constant currents applied by means of the electric flagellation.

3. It is, without dispute, the energetic effect of the immediate currents of tension directed over the flat muscles and vessels of the skin, which dissipate the passive hyperæmias and puffy swellings of the skin which are secondary in the aforesaid paralysis.

In 1867 Dr. Joseph Dropsy, of Cracow, presented to the International Medical Congress a memoir on generalised electricity, founded on new processes, from which we take the essential points.

It is necessary, in treating diseases of the centrifugal function, to apply positive electricity to the top of the head and to the pit of the stomach, and negative electricity to the hands and feet. It is necessary, in treating diseases of the centripetal function, to use negative electricity at the top of the head and to the pit of the stomach, and positive electricity to the hands and feet.

1. The sensitive nerves can only respond to effects to which they are forced through their physiological nature.

2. The motor nerves will contract or retract.

3. The trophic nerves will only serve the purpose of nutrition, and the transformation of organic and organised substances. They will lend themselves to the processes of secretion and excretion.

We have stated in our general rules of electro-therapeutics, that the causes of the affections submitted to electrization must never be lost sight of, and as diseases of motility are the most frequent, we will examine the etiology of the disorders of motility without paralysis. It can be

produced (*a*) by alteration of the sensibility, (*b*) by derangement of the equilibrium of the antagonistic muscular parts, (*c*) by suspension of the localised power of movement, (*d*) by a disproportion between normal impulse of will and excitability, as well as the conducting capacity of the different parts of the nervous system, (*e*) by general disturbance of the cerebral functions without total suspension of the last.

1. The antispastic effects of the constant galvanic current manifest themselves visibly, (*a*) against the reflex spasms (*i. e.*, celepharosparmes, (*b*) against trembling of the limbs, (*c*) against paralysis agitans, (*d*) against mystagamas (coma-virgil), (*e*) against stuttering, (*f*) against chorea.

2. The antiparalytic effects are seen, (*a*) against partial secondary paralysis, and atrophy, with or without contractions, as the sequela of articular or muscular rheumatism, (*b*) against primary and secondary atrophies of the muscles "das premierstades," (*c*) against traumatic paralysis, (*d*) against hemiplegia, (*e*) against paraplegia, and tabes dorsalis.

3. The catalytic effects of the constant galvanic current are seen : (1) by dilatation of the vessels which contain blood, and of the lymphatics which clear the cells of blood, or of stagnant lymph; then by reabsorption of effusions, establishing a circulation of fluids in the interior of

the tissues. (2) By a chemico-electrolytic change, joined to an electrodynamic removal of the fluids. (3) By diminution of pain after lesions and traumatic inflammations.

We may thus rely on these catalytic effects.

1. Against phlegmon of the joints—either acute, traumatic, or chronic ; (a) against chronic, articular, or muscular rheumatism of the tendons, of the sheathes or periostitis ; (b) against neuralgia ; (c) against deep-seated inflammations of the spinal cord—the consequences of which are paralysis of the lower extremities, of the urinary organs, and of the rectum ; (d) against deep-seated inflammations of the brain, accompanied by trembling and other spasmodic paroxysms.

2. Against exudations (hydrarthrosis).

3. Against painful and inflamed tumors.

The continuous currents, operating rapidly or slowly, then the interruptions, rapid or slow, of the successive currents, produce different effects ; consequently a complete apparatus should be constructed in order that the current may operate by shocks which succeed each other rapidly or slowly ; the effects of the rapid discharges of the current on the muscular contractility of the muscles is condensed in the inducted current, and is relaxed very soon after the suspension.

In this last case, the less rapidly the discharges follow each other, and the shocks produced by

the suspensions diminish, the more rapidly the separate discharges follow. The muscular sensibility is more powerfully stimulated by rapid discharges of the current than by interruptions which slowly follow each other. The muscular tone is increased by the rapid discharge of the current as soon as it is diminished and returns to its normal state; a prolonged influence of the current can even produce contraction of the muscle.

The nourishment of the muscles is more active under the influence of currents rapidly discharged, which may be obverted in atrophies.

The electro-cutaneous sensibility is much more stimulated by a strong current rapidly discharged than by a slowly interrupted current.

The diseases amenable to treatment by electro-therapeutics are (1) Neuralgia; (2) Anæsthesia; (3) Spasms, with different degree of convulsive movements; (4) Paralysis, including local paralysis, weak vision, amaurotic affections of various degrees, the loss of smell and taste, the different degrees of deafness, aphonia, and raucedorocis, whether congenital or idiopathic; (5) Certain irregularities of secretion and excretion; (6) Phrenopathics.

CHAPTER XII.

RHEUMATISM AND GOUT.

IT is not my intention to discuss the cause of the many varieties of these diseases. Suffice it to say that it must depend on some change in the system and poison of the blood, the chemical and physiological nature of which we will not touch on.

From the earliest periods, electricity by various methods of application, has been used in the treatment of rheumatism, especially of the chronic type, and this with paralysis are the diseases for which the original experiments of electro-therapeutics were most frequently conducted—and for this reason, that they, of all other diseases, are more frequently obstinate to ordinary medical treatment. That this is so, we need only refer to many well authentic works of empirical authors, as Rev. J. Wesley, 1759.

The number of cases of long standing rheumatism, gout, and paralysis, neuralgia, &c., cured

by him and others with the old frictional and now antiquated batteries, have only to be read to be relied on. In scarcely a town in the United Kingdom, on the continent of Europe and America, do we not hear of surprising cures of various cases by the haphazard and unskilful application of this agent by quacks and others ? Can we be surprised then, that in the hands of the educated and experienced physician it will produce more astounding results ? For the last fourteen years I have been engaged in this practice, and the more I see of it, the more I am persuaded that if we have a specific for these diseases, we have it in electricity *applied in its various ways.*

Rheumatism is a constitutional disease, and requires constitutional treatment. Excellent results are obtained by Faradization or galvanization to the affected joints. But to confine the treatment to the affected joint or joints is unphilosophical, unnatural, and unsatisfactory, for the obvious reason that it attacks merely a local symptom, which may at any time be removed to other and remote parts of the body.

The true treatment, in the mind of any rational physician, should be to lay the axe at the root of the tree, and by bringing the whole system under any remedy (medicinal or otherwise) so cure the disease.

Experience proves that the ordinary routine of treatment fails in numberless instances, and after wearying the patients and their doctors, they are sent to one of the numerous spas and baths at home or abroad, and in many cases return no better, or perhaps somewhat relieved, and make up their minds to a life of suffering, and give up all hope of regaining health from ordinary means. To such I would specially recommend a careful perusal of this short treatise.

Having been for many years prejudiced against the *electro chemical bath*, as described at page 124, but many persons who had themselves experienced its good effects in London and elsewhere, and were entirely trustworthy, led me to examine more especially into this method of electro-therapeutics; and having visited the baths of Dr. Caplin and others in London, and those in Paris, Berlin, New York, &c., I was in a position to test it in my own establishment, which I have done at much expense since the first issue of this work, and I have arrived at the conclusion, that if we wish a remedy to act on the entire constitution, to remove impurities, effect organic changes, and best imitate nature, we have it in this general constitutional administration of electricity; and without wishing to cry it up as a cure-all, or take away from the undoubted effects of the medical art, I do most unhesitatingly as-

sert that if there is one specific in nature for rheumatism and gout, especially of its chronic type, it is electricity so applied, for it is nature's own remedy for the removal of that which disturbs the system.

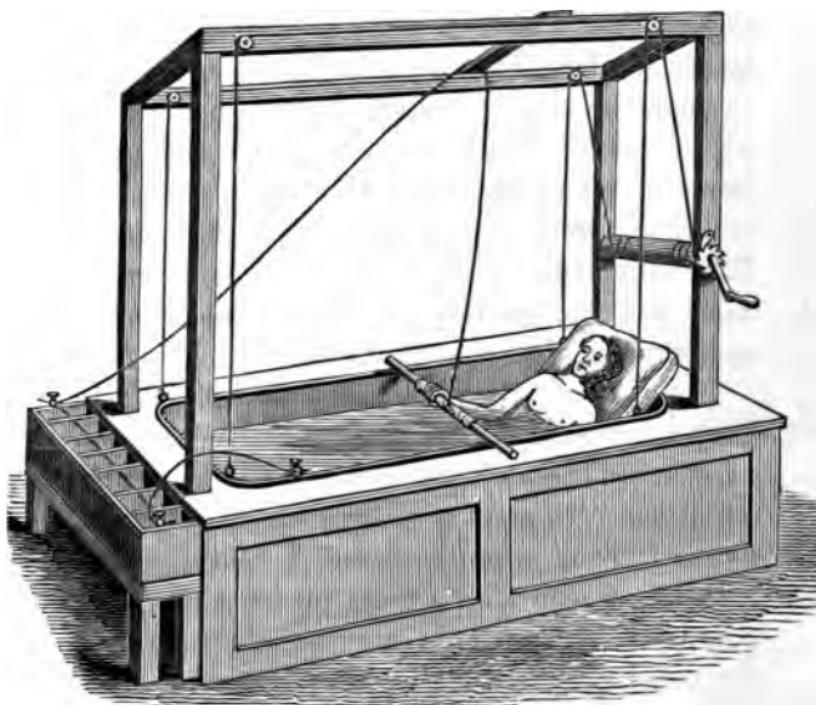
The electro-chemical bath is capable of removing from the system the results of long-continued medication, as mercury, silver, arsenic, lead, zinc, iodine (as the iodide of potash), &c. I have been surprised often, at the quantity of mercury, iodides, &c. that have been deposited on the sides of the baths, from patients who had not been taking these medicines for years. Cases of this kind have been so frequent, and are so constantly recurring, that I should be most happy to shew such deposits for chemical analysis to any medical man who would wish, with the history of the patients, which are too numerous to mention here.

I ask, then, if we have in this remedy what will remove metallic impurities from the system, is it astonishing that it will remove other inorganic impurities? If it does so, and if rheumatism, gout, or rheumatic gout, or any other disease which depends on a specific blood poisoning, impurities, or obstruction to the nervous system, then this general application of nature's own remedy should be a specific, if we only knew how to employ it.

Before pooh-poohing a matter which medical men know confessedly little about, let them investigate it and learn for themselves. The "Electro-Chemical Bath" is a bath by means of which *electricity* is so applied as to promote all the chemical phenomena of the human organism. It differs from all other means of applying electricity, inasmuch as it is introduced at once and directly, by a gentle and continuous current, *into the whole body*, thereby saturating the whole organism, and promoting the functions of all the vital organs. By decomposition it eliminates impurities and inert substances from the blood, which by their presence in the system present an obstacle to the normal performance of its functions.

By this method we obtain as many currents as there are pores in the skin, *i.e.*, seven or eight millions according to size, etc., the number of pores being computed to average 3,528 to the square inch. In some cases of chronic arthritic rheumatism, and in other cases, the local application of electricity is greatly enhanced by having it administered in the bath. For this special appliances are necessary.

The bath, as before described, consists of copper. The patient is placed on a wooden stretcher to insulate him from the copper, and is immersed in water of a high temperature



acidulated with nitric, muriatic, or sulphuric acid (as the case may seem to demand). About five ounces may be requisite for every ordinary bath. One end of the bath is connected with the negative pole of a pile of thirty pairs of plates by means of a screw, and the positive pole is held by the patient alternately in the right and left hand. The positive electrode is made of iron, and covered with linen, so as to diminish the calorific effect of the current, which is very intense, and might cauterize the hand. The

current then enters the body by the right or left hand, circulates from the head to the feet, passes through the entire system through the water, which is seen by bubbles of water over the surface of the body (decomposition of the water), to meet the negative pole at the side of the bath. The bath then becomes of itself the negative pole, and the patient may be likened to the electro-plate process, only reversed.

The patient usually remains from twenty to forty minutes in the bath, and without exception experiences the most exhilarating and agreeable sensations. In cases of indigestion or dyspepsia, particularly of a gouty nature, I have found a bath taken soon after a meal produce the most beneficial effects. This may seem strange, as the usual rule in bathing is to wait some time after meals; but the electric bath, acting directly as a stimulant and corrective to the digestive organs, promotes digestion, and in this manner relieves the symptoms.

Since I have used these baths, I am more and more convinced that we have in it a powerful curative agent. Did space permit, I could narrate well authenticated cases of chronic gout, rheumatism, paralysis, and other diseases, especially of a syphilitic nature, that have been cured or greatly relieved by this remedy, combined, of course, with localised electrization and *other medical adjuncts.*

A P P E N D I X.

THE REQUISITES OF AN ELECTRICAL ROOM.*

FOR hospital or private practice, the medical man should have at his command :—

I. *Franklinic Electricity.* 1. A cylinder or plate machine; the latter is the best. (a) The cylinder should measure at least a foot and a-half to two feet in diameter, and ought to have a multiplying wheel for turning, so that the rotations may be rapid. (b) The plate machine should be at least eighteen inches or upwards in diameter. 2. Brass chains, or strands of covered flexible wire should be in readiness to connect the patient with the prime conductor, or to attach the director for administering sparks. A thin flexible copper wire has some advantage over

* I am indebted for the hint of most of what is contained in this Appendix to a recent publication: "Lectures on Clinical uses of Electricity," delivered in University College Hospital, by Dr. J. Russell Reynolds, F.R.S. London: Churchill, 1871.

a chain, inasmuch as the sharp edges of the links in the latter waste very much of the electricity that is employed. 3. A large glass-legged stool, on which a chair is placed ; or, a sofa with glass legs ; or, cups of glass in which the legs of a chair or sofa may be placed, which should be covered with leather and not with stuffed or woollen material. 4. A director, *i.e.*, a brass knob attached to a glass handle by a strong brass wire, to which the electricity may be conveyed from the prime conductor, by the wire or chain mentioned before (§ 2). 5. A Leyden phial, at least eight inches by four in size. 6. A discharging rod, with glass handle and flexible joints. The most important point in the care of this apparatus is to keep it free from damp and dust.

II. *Galvanic Electricity.* Apparatus for galvanism are so numerous, that I shall only mention those in general use. 1. The battery, such as described on page 13 (Daniell's), is what I am in the habit of using. I have a battery of this kind of one hundred cells. An arrangement is made whereby any power, from five cells up, can be at once put into action. Messrs. Weiss make a battery of great portability, constancy, regulation, and strength, occupying a small space ; but, from my experience, not to be compared to a *properly minded Daniell's* (Muirhead's) battery. Other apparatus, as that of Stöhrer,

Elliott, &c. are admirable in some respects, and no doubt fulfil all intentions that may be required. For hospital use, a convenient arrangement is to have these cells placed on castors, so that they can be wheeled to the bedside of the patient. 2. Handles for the application of the current. These should be of various sizes, according to the nature of the case, the region to be operated on, &c. as described from page 50. 3. Wires covered with silk, cotton, or gutta-percha of at least six yards in length, to connect the conductors with the poles of the battery. 4. An interrupter may be required, but I have never found it necessary. The battery should be put out of action when not in use. The conductors and sponges should be kept scrupulously clean, the sponges being washed in a little acidulated water each time they are used.

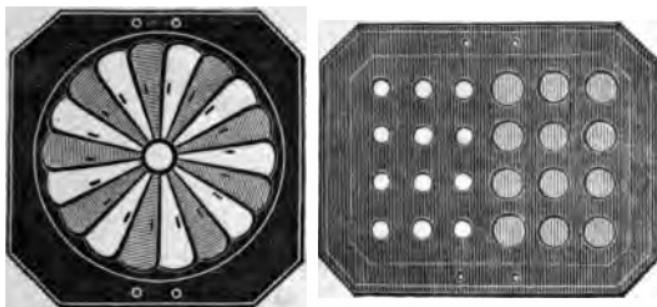
III. *Faradization.* 1. The battery. This is to be found in many forms, but the most convenient for general use is that of Stöhrer (page 41) of one or two cells, or Ladd's (page 36), which is the most portable of any I know in use. Conductors for application : (a) a pair of dry carbon points; (b) a pair of conductors with sponges, about half an inch in diameter; (c) a pair of conductors, known as Duchenne's, covered with chamois leather; (d) a bent, probe-shaped conductor, covered with leather at the end; (e) a

brush of metallic wire. Three covered wires as described for galvanism.

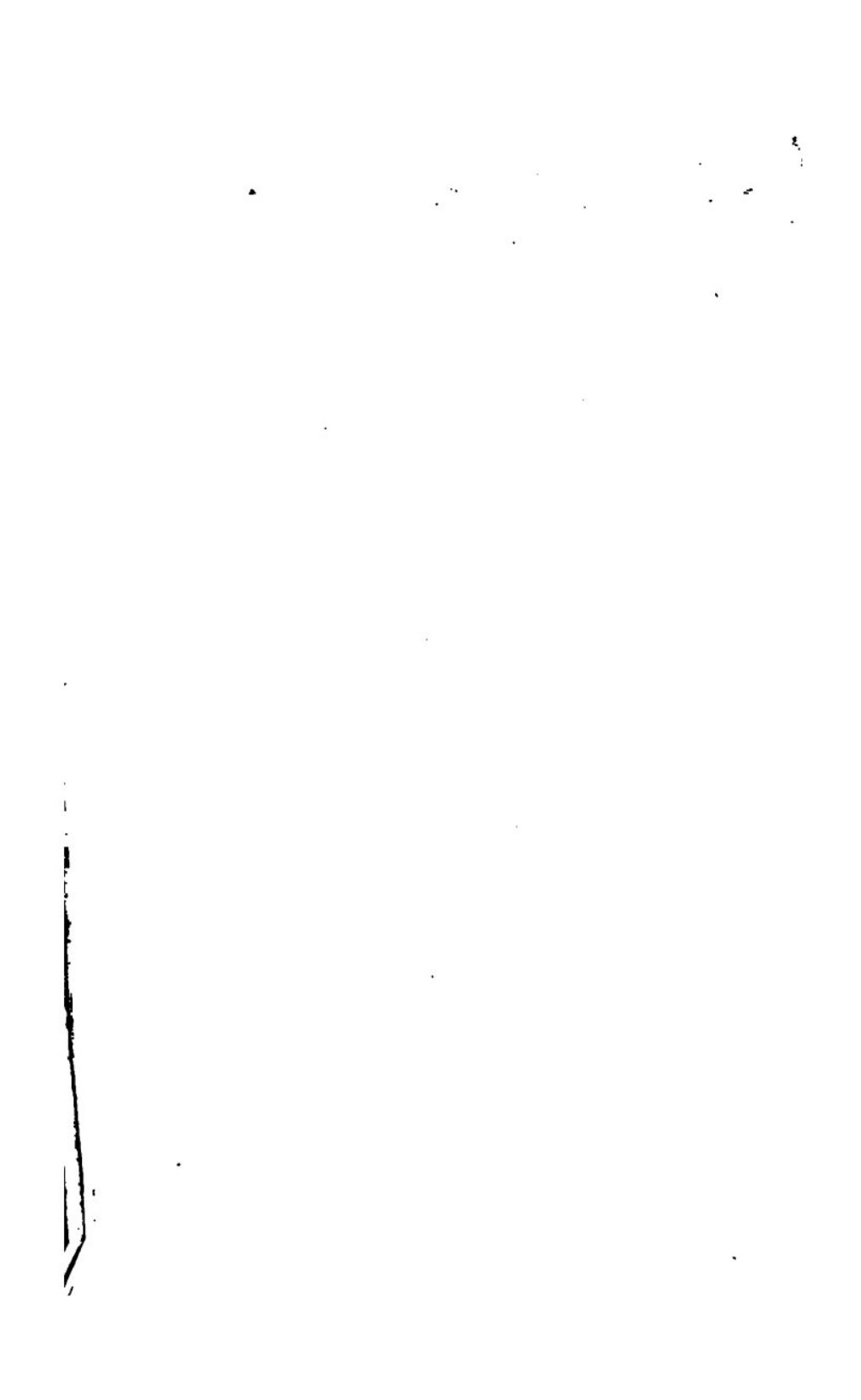
IV. In addition to these conductors for conveying electricity into the depths of the tissues (directly), needles of platinum, gold, or gilt steel, are used as described on page 129; and finally, the electric bath, which may be either employed with an induced current as a general stimulant, or with the galvanic pile, as described on page 122, as a means for promoting general changes in the system, removing obstructions or impurities—metallic or otherwise, and in that way cure the patient when all other means fail. The patient will, in many cases, find great benefit from wearing chain band and belts, as Pulvermacher's, in addition to other treatment. A convenient arrangement for making prolonged or continuous local applications of very mild galvanic currents, is the electric disc of Dr. Garratt. These are made of alloy—magnesium and zinc—for the negative, and silver for the positive pole. The surface of the body forms a moist connexion between the pairs, which are insulated by thin rubber. The discs are made in two general varieties, the circular and the oblong, the latter being used for the limbs or back; the former, which is very flexible, can be applied to almost any part of the body. The action may be increased by wetting the under

part with acidulated water, and may be worn day or night for any length of time. In myalgia, neuralgia, local pain, rheumatism, lumbago, &c., I have found great benefit from their use.

The discs that are made for me are covered with an impervious material like "spongio pipeline," which I find of great advantage.



It is a fact of interest that these methods of continuous local application of electricity, are but a renewal of the days of Pliny, when necklaces of amber were worn by women and children for the sake of their remedial properties.







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